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Pesticide Use and Awareness on Pemba Island

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Abstract

Use and awareness of pesticides by 301 farmers on Pemba Island, Tanzania, were surveyed, in order to assess practices and perceptions of pesticide use. Surveys were conducted in both peri-urban farms and rural farms, which were either irrigated or rain-fed. Results showed that while the overwhelming majority of farmers on irrigated fields used pesticides frequently, farmers located in rain-fed irrigation largely farmed without pesticides. Likewise, peri-urban farmers made use of pesticides far more than rural farmers. Of the farmers who did use pesticides, an average of Tsh 17,219 was spent annually on Rogol, Satunil, Dimethoate, Simithion, Thionex and Dursban. Most of these farmers also reported a lack of protective gear during application, often resulting in health problems. When choosing a pesticide for their crops, farmers indicated that effectiveness, cost and availability, respectively, were the most important factors. Many of the farmers currently not using pesticides indicated that this was due to monetary constraints, and would employ pesticides if able. Nearly half of all farmers surveyed had not had any training or education regarding appropriate use and safety of pesticides. Based on survey results, this study developed an appropriate, accessible pesticide education campaign including posters and field seminars to help educate the farmers on the serious risks that pesticides pose to both human health and the environment, and to encourage proper application in order to minimize such negative effects.

Introduction

I. An Overview of Pesticides

Almost all modern and traditional cultures rely on agriculture as a means of providing a steady food source to their people. In order to maximize the size and success of their crop yield, farmers have turned to pesticides. Pesticide use has increased considerably since the Green Revolution, a shift in agricultural practices and techniques that evolved from new technologies and developments after the Second World War. Technological advances, particularly in the form of chemical products, led to the creation of high efficiency pesticides and fertilizers, enabling a large increase in crop yield. These technologies were developed in the United States and quickly were implemented globally. As a result, much of the agriculture in the world today relies heavily on the protection provided by pesticides.

As population increases and agricultural activity grows, an increased use of chemicals is required to satisfy local and global demand. Pesticides kill or sterilize pests that inhibit the growth or diminish the value of a certain crop. Chemicals can make it possible to grow crops in conditions where otherwise successful yield would be improbable. Without the employment of pesticides farmers run the risk of crop failure, affecting not only their own income, but also food availability and prices for the consumers. The need for reliability and continual success in the agriculture industry is too great for most to face without pesticides.

The American Food and Agriculture Organization (1986) defines pesticides as: "any substance or mixture of substances intended for preventing, destroying or controlling any pests including vectors of human or animal disease, unwanted species of plants or animals causing harm during or otherwise interfering with the production, processing, storage, transport, or marketing, of food, agricultural commodities, wood and wood products, or animal feedstuffs." Pesticides have been classified according to various characteristics. One such classification is based on target pest, including most commonly insecticides, herbicides, rodenticides, and fungicides. Another classification is based on their chemical structure, such as organochlorines, organophosphorous compounds, carbamates, pyrethroids and nitrophenols. Additionally, the World Health Organization classifies them by their toxicity level, derived from the hazards posed by both dermal and oral exposure (Koh 78).

When pesticides are applied with proper methods, the human and environmental impacts are minimal. Thus, multiple factors must be considered, relying on both quality of equipment

and the knowledge of the farmer. For every application, farmers should assess the type and concentration of chemical needed as well as the droplet size for a particular plot. Equipment should be in working condition, avoiding leaks or corrosion. Farmers should wear protective clothing to avoid physical contact or inhalation of chemicals during application. All contaminated materials, including clothing and containers, should be properly washed or disposed of (Paul 11-32). Using pesticides properly requires significant training and education to minimize the risks that accompany chemical use.

Developing countries account for approximately 20% of pesticide use worldwide; their population growth rate, however, far exceeds that of developed countries (Koh 78). This creates an exceptionally high need for maximizing crop yield, that will likely contribute to an increase in pesticide use in the future.

II. Environmental Impacts of Pesticides

While pesticides provide many benefits for agriculture and global health issues, they are not without negative impacts. Studies in the past have found that only 10 to 15% of the applied pesticide reaches its intended target. Consequently, a large portion of applied pesticides are absorbed into the earth or lost as runoff. This leads to pollution and bioaccumulation in untargeted organisms and environments (Stadlinger 5). As history has shown, many unintended effects have occurred due to pesticide use without fully understanding the long-term implications. These repercussions have included such impacts as the thinning of bird shells by DDT, leading to mass egg mortality rates and a drastic drop in population size for species like the bald eagle who were consequentially listed as an endangered species. There have also been incidences of high levels of mutations and sterility in agricultural runoff zones, altering the natural reproduction and survival rates of species (Anthony 10).

Another factor that contributes largely to environmental pollution is the improper storage and disposal of pesticides. Pesticides require storage in dry, secure locations to avoid unintended contamination, and to safeguard the chemicals from children and animals. Heavy rains can increase the instances of unwanted vector transport, as chemicals travel easily and quickly through water. In Africa, most facilities for pesticides are insufficiently regulated, leading to leaching of highly concentrated chemicals into the surrounding environment (Ondieki 32).

III. Human Health Impacts of Pesticides

In addition to contamination in the environment, pesticides can also have negative effects on human health. Humans can be exposed to pesticides both directly and indirectly, which can lead to acute and chronic health problems.[1] Direct exposure occurs via dermal, respiratory or oral means, whereas indirect exposure is a result of contamination of water, air or food (Koh 89). In 1986, the World Health Organization (WHO) found that one million people worldwide suffered from pesticide-related health issues, 20,000 of which resulted in death (Matthews 707). However, due to a lack of education and inadequate training about pesticide poisoning, many cases go unreported by both farmers and officials, so these estimates are assumed to be low (Ngowi 1617). A 1989 survey estimated that 11 million pesticide-related health issues occur each year in Africa alone (Koh 82). Pesticide poisoning is most commonly reported from organochlorines, organophosphates, carbamates, pyrethroids, and nitro and chlorophenols. Acute symptoms include dizziness, disorientation, nausea, fever, and fainting; extreme cases can result in death (Koh 80). Chronic symptoms can include respiratory problems, permanent skin damage, and stomach ailments. Appropriate planning and application of pesticides can mitigate environmental and human health impacts.

IV. Tanzania and the Zanzibar Archipelago

Tanzania is located just south of the equator on the eastern coast of Sub-Saharan Africa. The Zanzibar Archipelago, which is comprised of Unguja and Pemba Islands, is located due northeast of Dar es Salaam in the Indian Ocean. Pemba Island, the smaller of the two, lies 50 kilometers north of Unguja. Though the Zanzibar Archipelago is a part of the United Republic of Tanzania, they maintain autonomous in many areas of governance, including agriculture and the environment (Stadlinger 3). Tanzania is estimated to have over 34 million people, with 70% of the working population employed in the agricultural industry, mostly through subsistence farming (Kishimba 48). The Zanzibar Islands have a total population of 1 million with 362,000 people residing on Pemba Island. Though Pemba Island is small, agriculture plays a large role in the economy with nearly 50,000 farmers involved directly in small scale farming according to the 2002-2003 Zanzibar Islands Census.

Plant Protection Services is the main governing body in charge of importing and regulating pesticide use in Zanzibar. It was founded in 1957 on Unguja Island, and came to Pemba Island in 1974. Plant Protection Services' responsibilities include quarantine of

[1] See Figure 1 in Appendix.

introduced species, field service and training, and conducting research (Mohammad Interview 2010). However, not all pesticide imports are regulated, as private licenses can be obtained that keep such imports off official record. Even with these private licenses, recent trends have shown an increase in governmental pesticide importation into the Zanzibar Archipelago in the last twenty years as shown in Figure 2 (Stadlinger 14).[2]

V. Agriculture and Pesticides in Rural Tanzania

In the few studies conducted in rural Tanzania, it can be gathered that pesticide use is frequent but often lacks sufficient environmental and health standards. A 2007 study found that 68% of farmers in northern Tanzania had experienced some degree of pesticide poisoning, but many incidences went unreported because their symptoms were accepted as commonplace (Ngowi 1624). An inadequate usage of protective gear and suitable equipment was also observed during pesticide application. Pesticides were often stored inside households alongside food, or repurposed as containers to hold food and drinking water (Ngowi 1623). This study also found that one-third of the farmers applied pesticides in mixtures. This kind of application provides the reverse of the intended effects. By spraying small amounts of many pesticides, only the weaker pests are killed while enabling the strongest to survive. Then, this generation reproduces and creates a new population of resistant pests (Ngowi 1623). Lastly, studies reported an excessive frequency of pesticide application. Both types of improper application reduce the effectiveness of the chemical while increasing the chances of harm to the surrounding environment.

Many of the problems relating to improper pesticide application stem from two main areas: lack of resources and lack of education. Oftentimes, farmers have insufficient capital to buy effective clothing or gear, leading to equipment leakage and increased exposure to chemicals (Matthews 712). In addition, many distributors sell farmers chemicals or mixtures of chemicals without labels or instructions. This can leave the calculations of application methods up to the interpretation of the farmer, without the needed initial information, such as concentration or directions for use. Environmental and health concerns are often not available to farmers, leaving a large population uneducated and vulnerable to the effects of pesticide use.

VI. Pilot Study Findings

[2] See Appendix.

Use and awareness of pesticides by 47 farmers in the Wete District of Pemba, Tanzania were surveyed in a pilot study conducted during October 2010. This survey collected data on a broad range of information relating to the practices and perceptions of pesticide use. The information gathered was then used to assess the logistics of pesticide use along with farmers' general educational awareness of pesticides in the district. The results showed that among rice and vegetable farmers Rogol, Satunil, Dimethoate, Simithion, Thionex and Dursban are the most commonly employed pesticides to combat pest problems.

Pesticide application occurred during the heavy rains of March to May and the lighter rains of October to November, and on average farmers in the Wete District each spent Tsh 14,267 annually on pesticides. When asked what was the main influence in choosing a pesticide 55% responded with the effectiveness of the chemical, 15% cost, and 2% availability. 85% of the farmers applied pesticides with a knapsack sprayer, 40% of whom indicated wearing absolutely no protective clothing. 66% of the farmers who answered reported having felt symptoms of pesticide poisoning after application; 47% experienced dizziness, 19% experienced itching, 9% experienced nausea, and 3% experienced burning skin. 47% had received no training or education relating to pesticides.

The majority of the farmers applied pesticides during the rainy seasons. The high use of pesticides during the rainy seasons enhances the likelihood of chemical pollution in the environment, as it introduces an effective vector for chemical transport. Without careful application, the risk for negative impacts on the surrounding environment greatly increases during this time. In addition, the findings indicated remarkably high use of pesticides for the small-scale farming that occurs in the area. This, coupled with the lack of protective gear worn during application, raises concerns. Such frequent exposure without protective equipment could lead to serious chronic illnesses as well as acute poisoning. The findings of the pilot study suggested a need for further research and the development of effective training programs for farmers.

VII. Importance and Relevance of Study

The effects pesticides are having on both the environment and human health in developing countries have yet to be thoroughly studied. However, research has indicated that pesticide use is increasing in the developing world as population growth stresses the agriculture industry. Research has also indicated a deficiency in pesticide education and little awareness

among rural farmers, raising concern for the future. Studies have been conducted both on the Tanzania Mainland and Unguja Island, yet no information is available regarding Pemba Island. With Pemba Island's economy being heavily based in agriculture, the need for assessment of pesticide application and knowledge thereof is essential. The aim of this study is to gain a comprehensive understanding of the state of pesticide use and the awareness of the appropriate application and precautionary measures taken by local farmers. Furthermore, its purpose is to provide awareness via posters and educational meetings that aim to inform farmers on the central issues surrounding pesticide use on Pemba Island.

Study Area

The Zanzibar Archipelago consists of two main islands: Pemba Island and Unguja Island. Pemba Island, the smaller of the two, lies 50 kilometers north of Unguja Island and is home to 362,000 people.[3] It receives an annual average rainfall of 1,900 mm, most of which occurs during the two rainy seasons of September to November and March to May (Khatib 2). Though the island is developing and becoming more urbanized, most communities are still traditional and based on agriculture. Most agriculture is small-scale or subsistence farming.

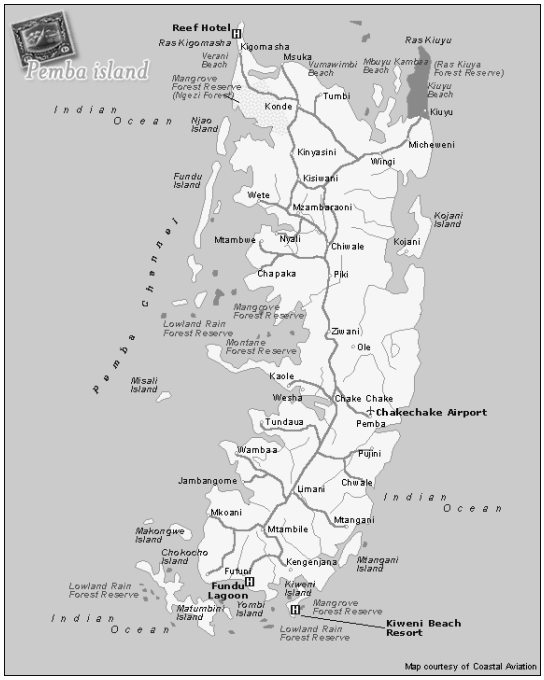


Fig. 2 – Pemba Island

[3] See Appendix for larger map.

According to the Pemba Agricultural Census of 2002-2003, Pemba Island is home to 47,666 people for whom farming is their sole occupation. The largest farming population on Pemba Island resides in the Micheweni District, in the northeast corner of the island, with an estimated 13,093 farmers. The Mkoani District, in the southwest corner, follows with 12,474 recorded farmers. The Wete District, located on the east coast of northern Pemba Island, is estimated to have 12,088 farmers. Historically, it is considered the agricultural center of Pemba, as it was the first farming district established and supported by the government. The Chake Chake District, though the largest urban center, hosts the least amount of farmers, at 10,011. Undoubtedly, far more people are involved in the agricultural industry through transportation, marketing, maintenance, and governance sectors, among others. Farmers in eight farming villages throughout the four districts were surveyed, including the villages of: Weni, Mangwena, Mjini Ole, Kiungoni, Kinowe Juso, Kinowe Rahikan, Kondeani, and Kipapo. Rural communities included: Mjini Ole, Kiungoni, Kinowe Rahikan, Kinowe Juso, and Kipapo. Peri-urban communities included: Weni, Mangwena, and Pondeani. The communities were also separated into categories based on how they were irrigated. Mjini Ole, Kinowe Juso, Kiungoni, and Kipapo were rain-fed communities, whereas Weni, Mangwena, and Kinowe Rahikan had irrigation canals. Pondeani had both irrigated and rain-fed plots.

Weni and Mangwena are two farming communities just outside of the city Wete. The government owns the land and leases it to the farmers in 0.1-hectare plots. Each community hosts over 70 farmers, and provides shared facilities such as irrigation channels and storage sheds. Based on their proximity to the urban center of Wete, they were considered peri-urban farming communities. Most of the crops produced are consumed by the farmers and their families or transported to Wete for sale.

Mjini Ole is a rural town located in central Pemba Island, also in the Wete District. The nearest urban center is the city of Chake Chake, which lies approximately 12 kilometers south of the village via the main road. No irrigation infrastructure is available, so the farmers rely on the rain to irrigate the rice paddies.

Kiungoni, Kinowe Juso and Kinowe Rahikan are three rural farming villages located in the Micheweni District. The closest urban center is Wete, over 13 kilometers away, however some facilities and resources are available in the town of Micheweni. Kiungoni and Kinowe Juso are primarily rain-fed, whereas Kinowe Rahikan has irrigation canals for the rice paddies.

Pondeani is a peri-urban farming village located in the Chake Chake District, just outside of the city of Chake Chake. Some irrigation canals are available but a good number of farmers use rain-fed irrigation for their crops.

Kipapo is located in the Mkoani District in the southern end of Pemba Island in the *shehia* of Chonga. Kipapo is a rural farming village that relies on rain-fed irrigation. The nearest city is Chake Chake, about 7.5 kilometers away.

Pesticides are available for sale primarily in the main urban centers of Wete, Mkoani, and Chake Chake.

Methodology

To gain comprehensive information about pesticide use and awareness, a concise three-page survey was created for the farmers. The survey covered three general sections, namely: personal information, pesticide use, and perceptions of pesticides. The survey included a total of twenty-seven questions. The survey was first written in English and then translated into Swahili with the assistance of a translator. Copies were made when necessary so that each farmer was able to fill out their own individual survey, and each farmer was given a pen to complete the survey and were able to keep it as compensation. Local farms in the communities of various regions throughout Pemba were visited and farmers were chosen at random based on who was willing to participate in the survey. Villages were chosen to represent either rural or peri-urban farming communities, with either rain-fed or irrigated rice paddies. These categories were used for comparison in the study. Peri-urban farming communities were defined as those communities that lie within a 5-kilometer radius of an urban center. In this study, these include the cities of Chake Chake, Wete, and Mkoani. Rural farming communities were defined as those communities that do not lie within the assigned 5-kilometer radii.

In addition to gathering surveys, both formal and informal interviews were conducted. A formal interview was held with Amour Mohammad, who is both a distributor of pesticides and an expert on local farming practices. This interview, as well as the informal interviews and conversations with farmers and pesticide retailers, pertained to general farming practices on Pemba Island, pesticide use and knowledge of local farmers.

Information from a pilot study was included in overall results, including answers from a similar survey used at Weni and Mangwena. The survey was altered slightly from the original

based on critical analysis of the questions and responses during the pilot study. Thus, some of the results are taken from a smaller sample size as the some of the answers from the pilot study have been omitted. These will be noted in the results.

Initiatives were then taken to create an educational program that would properly address the farmer audience, many of whom were anticipated to be illiterate. This included revisiting Pondeani, Kipapo, Weni, and Mangwena, and holding brief information sessions for the farmers, explaining the findings of the surveys and suggesting improvements. Posters were created with pictures advocating the use of proper gear and warning of precautions to be considered regarding the use of pesticides. A small donation of 12 pairs of boots, 20 masks, and 20 pairs of gloves were given to the farming communities of Weni and Mangwena.

Results

I. Demographics of Pemba Island Farmers

Table 1 – Demographic Results

	Total	Rural	Peri-Urban	Rain-Fed	Irrigated
Communities		Kiungoni, Mjini Ole, Kinowe Rahikan, Kipapo, Kinowe Juso	Weni, Mangwena, Pondeani	Mjini Ole, Kinowe Juso, Kuigoni, Kipapo	Weni, Mangwena, Kinowe Rahikan
Sample Size	301	217	84	190	74
Avg. Age	42.7	42.0	45.5	40.7	46.0
Sex	Male-36.9% Female- 63.1%	Male- 36.9% Female- 63.1%	Male- 36.9% Female- 63.1%	Male- 36.3% Female-63.7%	Male- 37.8% Female- 62.2%
Avg. Years Farming	18.3	18.9	16.5	18.5	18.5
Family History Farming	98.3%	99.1%	96.4%	99.5%	95.9%
Sole Source Income	95.3%	96.3%	92.9%	95.8%	93.2%
Avg. Plot Size	0.94 ha	1.02 ha	0.71 ha	1.0 ha	0.8 ha
Crops Farmed	Rice, Cassava, Bananas, Vegetables, Legumes, Corn, Spinach				
Avg. Years Education	4.3 (42.9% with no education)	4 (47% with no education)	5 (32% with no education)	4.1 (45.8% with no education)	4.1 (40.5% with no education)

i. Total Survey Sample

Of the 301 farmers surveyed, the average age was 42.7 years, with a range of 15 to 80 years and an average of 18.3 years experience farming. 98.3% of all farmers surveyed reported

having parents that farmed as well. For 95.3% farming was the sole source of income. Most commonly farmed crops included rice, cassava, bananas, vegetables and legumes, respectively, on an average plot size of 0.94 ha. Female farmers outnumbered males almost 2 to 1 with 63.1% of the survey population. Results showed that the average farmer received 4.3 years of education, with 42.9% of the survey population reporting no formal schooling.

ii. Rural vs. Peri-Urban

Rural regions included Kiungoni, Mjini Ole, Kinowe Rahikan, Kipapo, Kinowe Juso and had a total sample population size of 217; Weni, Mangwena, and Pondeani were considered peri-urban, with a total of 84 farmers surveyed. Both rural and peri-urban were comprised of a 63.1% female work force with an average age of 42 and 45.5 years respectively. On rural farms, the average farming experience was 18.9 years on a plot size of 1.02 ha. In peri-urban regions, farmers had 16.5 years experience and a plot size 0.71 ha on average. Rural regions reported slightly higher percentages for both a family history of farming and for farming being their sole source of income. Peri-urban regions also observed slightly higher education levels, with an average 5 years of schooling compared to the rural average of 4. In the peri-urban population, 32% reported having received no formal education, whereas in rural populations the figure was 47%.

iii. Rain-Fed vs. Irrigated

Rain-fed regions included Kiungoni, Mjini Ole, Kinowe Juso, and Kipapo with a total population size of 190 farmers; irrigated regions included Weni, Mangwena, and Kinowe Rahikan with a total population size of 74 farmers. A similar female-based work force, age, and farming experience were found in both areas of study. Both rain-fed and irrigated also had high reports of a family history of farming, 99.5% and 95.9% respectively, as well as for farming being their sole source of income, 95.8% and 93.2%. Farmers on rain-fed irrigated farms had an average plot size of 1 ha while farmers on irrigated field had a slightly smaller average of 0.8 ha. An average education of 4.1 years was discovered for both rain-fed and irrigated farmers, though rain-fed contained a slightly higher percentage of 45.8% of farmers receiving no education, compared to the 40.5% of farmers located on irrigated fields.

II. Pesticide Use by Pemba Island Farmers

Table 2 – Pesticide Use Results

	Total	Rural	Peri-Urban	Rain-Fed	Irrigated
Communities		Kiungoni,	Weni,	Mjini Ole,	Weni,

		Mjini Ole, Kinowe Rahikan, Kipapo, Kinowe Juso	Mangwena, Pondeani	Kinowe Juso, Kuigoni, Kipapo	Mangwena, Kinowe Rahikan
Sample Size	301	217	84	190	74
Population Using Pesticides	53.2% (160)	35.9% (78)	97.6% (82)	26.8% (51)	100% (74)
Names of Pesticides Used	(46.3% didn't know)	(73.1% didn't know)	(20.7% didn't know)	(86.3% didn't know)	(29.7% didn't know)
When Pesticides are Used*	Rainy Seasons				
Number of Uses Per Season*	1,2,3				
Avg. Annual Cost *	17,219 Tsh	23,682 Tsh	10,576 Tsh	28,372 Tsh	14,853 Tsh
Storage*	House- 12.2% Farm- 20% Does Not Store- 57.4%	House- 14.1% Farm- 14.1% Does Not Store- 60.2%	House- 8.6% Farm- 34.3% Does Not Store- 54.3%	House- 17.6% Farm- 21.6% Does Not Store- 49%	House- 7.4% Farm- 0% Does Not Store- 81.5%
Application Type*	By Hand- 9.4% Knapsack Sprayer- 77.5% Didn't Know- 2.5%	By Hand- 62.8% Knapsack Sprayer- 19.2% Didn't Know- 3.8%	By Hand- 0% Knapsack Sprayer- 91% Didn't Know- 1.2%	By Hand- 28.8% Knapsack Sprayer- 50% Didn't Know- 38.5%	By Hand- 0% Knapsack Sprayer- 85.1% Didn't Know- 2.7%
Protective Gear Used* (Anything less than 10% not listed)	None- 21.3% Long sleeve shirt and pants- 54.4% Gloves- 27%	None- 14.1% Long sleeve shirt and pants- 51.3% Glove- 37.2%	None- 28% Long sleeve shirt and pants- 53.7% Glove- 17.1%	None- 9.6% Long sleeve shirt and pants- 44.4% Glove- 48.1%	None- 33.8% Long sleeve shirt and pants- 45.9% Glove- 17.6%
Reasons for no Protective Gear*	Availability- 54% Cost- 42.5%	Availability- 41% Cost- 50%	Availability- 45.7% Cost- 62.9%	Availability- 31.5% Cost- 55.5%	Availability- 55.6% Cost- 33.3%
Pesticide Acute Poisoning*	53.1% (Mostly dizziness)	51.3% (Mostly dizziness)	65.9% (Mostly dizziness)	59.3% (Mostly itching)	59.5% (Mostly dizziness)
Why Certain Pesticides are Bought	Price- 12.3% Availability- 21% Effectiveness- 45.8%	Price- 11.7% Availability- 24.9% Effectiveness- 47.8%	Price- 19% Availability- 15.5% Effectiveness- 48.8%	Price- 12.4% Availability- 21.9% Effectiveness- 51.1%	Price- 12.2% Availability- 20.3% Effectiveness- 45.9%
Disposal of Pesticide Containers*	Throw Away- 51.4% Reuse for Pesticides- 17.3% Reuse for Food and Water- 3.5%	Throw Away- 45.2% Reuse for Pesticides- 18.5% Reuse for Food and Water- 4.4%	Throw Away- 86.5% Reuse for Pesticides- 16.2% Reuse for Food and Water-0%	Throw Away- 40.7% Reuse for Pesticides- 20.4% Reuse for Food and Water- 5.6%	Throw Away- 59.3% Reuse for Pesticides- 11.1% Reuse for Food and Water-0% Burry- 37%

* Calculations were made from those who did use pesticides; therefore sample size is smaller than it appears.

i. Total Survey Sample

The results showed that of the farmers surveyed, rice was the most commonly cultivated, followed by cassava and vegetables. 53.2% of farmers reported using pesticides, 46.3% of which did not know the names of the pesticides they used. Those who did know the names reported a total of 17 different pesticides with Rogol, Satunil, Certified, Base, and Thionex, being the most commonly employed. Pesticide application occurred during the heavy rains of March to May and the lighter rains of October to November, with individual applications either, 1,2, or 3 times per season. On average, farmers spent 17,219 Tsh annually on pesticides. When asked what the main influence in choosing a pesticide, 55% responded with the effectiveness and 42.5% responded with availability.

An overwhelming majority of the farmers, 77.5%, applied pesticides with a knapsack sprayer, while 9.4% applied pesticides by hand. It was also found that the use of protective clothing during application was minimal. 54.4% of farmers reported wearing full-length pants and shirts, while 27% used gloves. Less than 10% used face shields, breathing devices, goggles, or rubber boots, and 21.3% indicated wearing absolutely no protective clothing at all, of which availability and cost were found to be the limiting factor respectively. While 57.4% of farmers reported not storing pesticides, 12.2% stored them in their house, while 20% kept pesticides on their farms. In regards to disposal of pesticide containers, 51.4% threw containers away, 17.3% reused containers for pesticides, and 3.5% reported repurposing containers for food and water. Pesticide poisoning was observed to be commonly experienced, with 53.1% of farmers having felt some symptoms of acute pesticide poisoning after application of pesticides: mostly through dizziness and itching.

ii. Rural vs. Peri-Urban

In rural areas, 35.9% of farmers reported using pesticides, 73.1% of whom did not know the names. However, in peri-urban areas, 97.6% of farmers reported using pesticides of which only 20.7% did not know the names. Rural farmers spent an average of 23,682 Tsh on pesticides annually, while peri-urban farmers reported an annual cost of 10,576 Tsh. Effectiveness of chemicals was the biggest influence in choosing pesticides for both areas. However, after

effectiveness, most rural farmers reported availability as the biggest influence on buying pesticides, while peri-urban farmers reported price.

Of the farmers who did use pesticides, application by hand was the most popular method for rural farmers with 62.8%, and 19.2% using backpack sprayers. In peri-urban farms the backpack method was most popular with use by 91% of farmers, while none reported applying pesticides by hand. In both rural and peri-urban areas farmers reported wearing little protective gear, with long sleeve shirts, pants, and gloves being the only protective items that were used by over 10% of the populations. 14.1% of farmers in rural areas and 28% of farmers in peri-urban areas reported wearing no protective gear at all, due to cost and availability respectively.

Over half of rural and peri-urban farmers reported not storing pesticides at all, buying just what was necessary for the particular application at hand. Of rural farmers 14.1% stored pesticides in their house and 14.1% stored pesticides on their farms. For peri-urban farmers, 8.6% stored pesticides in their house, while 34.3% stored pesticides on their farms. Disposal for rural areas consisted of 45.2% of farmers reporting throwing away containers, 18.5% reusing containers for pesticides, and 4.4% repurposing containers for food and water. In peri-urban areas 86.5% threw their pesticide containers away, 16.2% reused containers, and none reported repurposing for food and water. 51.3% of rural farmers reported pesticide poisoning, while 65.9% of peri-urban farmers stated they had experienced these symptoms, of which dizziness was the most popular side effect in both cases.

iii. Rain-Fed vs. Irrigated

In rain-fed farms 26.8% of farmers reported using pesticides, 86.3% of which did not know the names. However, in irrigated farms, 100% of the farmers reported using pesticides of which 29.7% did not know the names. Rain-fed farmers spent an average of 28,372 Tsh on pesticides annually, while irrigated farmers reported an annual cost of 14,853 Tsh. Effectiveness of chemical was the biggest influence in choosing pesticides for both areas, followed by availability and price, respectively.

In rain-fed farms, 50% of farmers reported applying pesticides by backpack sprayer, and 28.8% reported application by hand. In irrigated farms 85.1% of farmers reported application of pesticides by backpack sprayers, while none indication application by hand. Both rain-fed and irrigated farmers reported wearing little protective gear, with long sleeve shirts, pants, and gloves being the only protective items that were used by over 10% of the populations. 9.6% of farmers

on rain-fed farms and 33.8% of farmers on irrigated farms reported wearing no protective gear at all. Results showed that farmers on rain-fed farms felt that cost more than availability was the main obstacle in obtaining protective gear. However, farmers on irrigated farms indicated the opposite, that availability was more of an obstacle than cost. When asked where pesticides were stored farmers for rain fed areas 17.6% stored pesticides in their house, 21.6% stored pesticides on their farm, and 49% did not buy enough pesticides to have the issue of storage.

For irrigated areas, 7.4% of the farmers surveyed stored pesticides in their house, none stored pesticides on their farm, and 81.5% did not store pesticides at all. Disposal for rain-fed areas consisted of 40.7% of farmers reporting throwing away containers, 20.4% reusing containers for pesticides, and 5.6% repurposing containers for food and water. In irrigated areas 59.3% of farmers threw their pesticide containers away, 11.1% reused containers, and none reported repurposing for food and water. 37% of farmers in irrigated areas indicated burying their containers after use. 59.3% of farmers on rain-fed land reported pesticide poisoning, while 59.5% of farmers on irrigated land stated they had experienced these symptoms, of which dizziness was the most popular side effect in both cases.

III. Identification and Classification of Pesticides Used

Table 4 – Pesticides used on Pemba Island farms and their classifications

Commercial Name	Active Ingredient	Pesticide Type	Chemical Type	WHO Class	GHS Class
Attikan	Cypermetlrin	Insecticide	Pyrethroid	II	3
Base	Fenobucarb	Insecticide	Carbamate	II	4
Certified	N/A	N/A	N/A	N/A	N/A
Diazon	Diazinon	Insecticide	Organophosphorous	II	4
Dume	Dimethoate	Insecticide	Organophosphorous	II	3
Dursban	Clorpyrifos	Insecticide	Organophosphorous	II	3
EM4D	2,4-DB	Herbicide	-	II	4
Furadan*	Carbofuran	Insecticide	Carbamate	IB	2
Karate	Lambda-Cyhalothrin	Insecticide	Pyrethriod	II	3
Kungfuu	Cyhalothrin	Insecticide (Ixodicide)	Pyrethroid	II	3
Preeder	N/A	N/A	N/A	N/A	N/A
Rogol	Dimethoate	Insecticide	Organophosphorous	II	3
Satunil	Propanil	Herbicide	Analide	II	4
Sumithion	Fernirothion	Insecticide	Organophosphorous	II	4
Systam*	Schradan	Insecticide	Organophosphorous	-	-
Thiodan	Endosulfan	Insecticide	Organochloride	II	3
Thionex*	Endosulfin	Insecticide	Organochloride	II	3

* Pesticides that have been banned or discontinued since 1994

Of the 17 chemicals listed, 15 could be deciphered and classified, with the most popular being Rogol, Satunil, Certified, Base, Thionex, Sumithion, Systam, and Dursban respectively. Certified and Preeder were listed by farmers but could not be found in any pesticides indices. Classifications were given in terms of active ingredient, chemical use, chemical type, WHO class, and GHS class.

13 of the chemicals were listed as insecticides, while the other two were listed as herbicides. Most of the pesticides were organophosphorouses, with the others being analides, pyrethroids, carbamates, and organochlorides. Three of the chemicals listed have been either banned or discontinued since 1994.

The World Health Organization classifies pesticides on four levels, including extremely hazardous, IA, highly hazardous, IB, moderately hazardous, II, and slightly hazardous, III. Aside from Furadan, all pesticides listed fell under the WHO class II of moderately hazardous. Furadan fell under the WHO highly hazardous class IB.

The GHS, or the Globally Harmonized System of Classification and Labeling of Chemicals, is a system of classification for acute toxicity. Satunil, Sumithion, EM4D, Diazon, and Base all fell under the GHS classification of 4, harmful if swallowed or in contact with skin. Dursban, Rogol, Thionex, Kungfuu, Dume, Attikan, Thiodan, and Karate were considered GHS class 3, toxic if swallowed or in contact with skin. Once again, Furadan received a more dangerous classification of class 2, fatal if swallowed or in contact with skin.

IV. Pesticide Awareness and Education of Pemba Island Farmers

Table 3 - Education and Awareness of Pesticides Results

	Total	**Rural**	**Peri-Urban**	**Rain-Fed**	**Irrigated**
Districts		Kiungoni, Mjini Ole, Kinowe Rahikan, Kipapo, Kinowe Juso	Weni, Mangwena, Pondeani	Mjini Ole, Kinowe Juso, Kuigoni, Kipapo	Weni, Mangwena, Kinowe Rahikan
Sample Size	301	217	84	190	74
Received Pesticide Training or Education	16.9%	6.5%	44%	5.8%	33.8%
Farmers' Perceptions of the Necessity of Pesticides	Very Necessary- 74.4% Somewhat Necessary- 17.7% Not Necessary-	Very Necessary- 73.3% Somewhat Necessary- 18% Not Necessary-	Very Necessary- 81.1% Somewhat Necessary- 16.2% Not Necessary-	Very Necessary- 70.5% Somewhat Necessary- 20% Not Necessary-	Very Necessary- 92.7% Somewhat Necessary- 3.7% Not Necessary-

	2%	2.3%	0%	2.1%	3.7%
Farmers' Perceptions of Pesticides and Human Health	Very Dangerous- 63.3% Somewhat Dangerous- 26% Not Dangerous- 4.7%	Very Dangerous- 59% Somewhat Dangerous- 29% Not Dangerous- 5.5%	Very Dangerous- 89.2% Somewhat Dangerous- 8.1% Not Dangerous- 0%	Very Dangerous- 57.9% Somewhat Dangerous- 29.5% Not Dangerous- 5.7%	Very Dangerous- 66.6% Somewhat Dangerous- 25.9% Not Dangerous- 3.7%
Farmers' Perceptions of Pesticides and the Environment	Very Harmful- 42.9% Somewhat Harmful- 33.1% Not Harmful- 14.6%	Very Harmful- 36.4% Somewhat Harmful- 36.4% Not Harmful- 15.2%	Very Harmful- 81.1% Somewhat Harmful- 13.5% Not Harmful- 2.7%	Very Harmful- 34.7% Somewhat Harmful- 35.3% Not Harmful- 16.8%	Very Harmful- 48.1% Somewhat Harmful- 44.4% Not Harmful- 3.7%
Pesticide Use on Pemba	Increasing- 39.2% Decreasing- 17.3% Same- 4.7% Didn't Know- 28.9%	Increasing- 27.2% Decreasing- 18.4% Same- 6.5% Didn't Know- 39.2%	Increasing- 71.4% Decreasing- 15.5% Same- 4.8% Didn't Know- 2.4%	Increasing- 20% Decreasing- 20% Same- 5.2% Didn't Know- 44.2%	Increasing- 66.2% Decreasing- 13.5% Same- 5.4% Didn't Know- 2.7%
Crops Needing Most Pesticides	Rice, Vegetables, Legumes, Tomatoes				

i. Total Survey Sample

Pesticide awareness and education appeared to vary greatly between sites, but overall it became clear that it was quite limited. Only 16.9% of farmers surveyed reported having received any education or training regarding pesticides or pesticide application. Yet, almost three-quarters of the farmers believed that pesticides were very necessary. Respondents appeared to recognize some adverse effects of pesticide use, with 63.3% reporting they felt pesticides were very dangerous for humans, and 26% felt they were somewhat dangerous. They also recognized the possible effects of pesticides on the environment; 42.9% expressed they felt pesticides were very harmful to the environment, and 33.9% felt they were somewhat harmful. Those surveyed reported mixed perceptions of changes in pesticide use on Pemba Island in the last ten years; 39.2% believed that pesticide use was increasing, 17.3% decreasing, and 4.7% stagnant. Most farmers agreed that rice, vegetables, legumes and tomatoes required the most pesticides to grow successfully.

ii. Rural vs. Peri-Urban

Breaking down the overall information into rural and peri-urban farms illuminates stark differences between the two. Far more peri-urban farmers had received pesticide training than rural farmers, at 44% and 6.5% respectively. Both indicated that pesticides were very necessary with over 98% of farmers at each site reporting pesticides are, at some level, necessary. While the majority of peri-urban and rural farmers both believed that pesticides were dangerous for human health, a larger quantity of peri-urban farmers than rural farmers reported that they were very dangerous, at 89.2% compared to 59%. The largest difference in perceptions was apparent in regards to the effects of pesticides on the environment, for which 81.1% of peri-urban farmers believed they were very harmful, whereas only 36.4% of rural farmers believed so. Again, mixed perceptions were evident in response to the changes in pesticide use on Pemba Island over time: 71.4% of peri-urban farmers and 27.2% of rural farmers believed pesticide use was increasing, but 15.5% and 18.4% believed it was decreasing, respectively.

iii. Rain-Fed vs. Irrigated

Contrasts between results are also evident between farmers on rain-fed and irrigated farms. A greater number of farmers on irrigated farms, 33.8%, reported having received pesticide education than those on rain-fed farms, 5.8%. Both responded that pesticides were very necessary, with farmers on irrigated farms reporting their importance more so. Farmers on irrigated farms reported the highest level of necessity for pesticides, at 92.7%. The majority of farmers on both irrigated and rain-fed farms perceived a threat of pesticides to human health. In terms of the effects of pesticides on the environment, 48.1% of farmers on irrigated farms and 34.7% of farmers on rain-fed farms believed pesticides to be harmful. Most farmers on irrigated farms, 66.2%, believed that pesticide use on Pemba Island is increasing, whereas an even number of farmers on rain-fed farms reported increasing and decreasing.

Discussion

I. Demographics of Pemba Island Farmers

i. Total Survey Sample

The survey conducted provided insight into not only the use and awareness of pesticides on Pemba Island, but also on the general demographics of farmers in the region. The work force was compromised of a nearly two-to-one ratio of female to male farmers, most of whom were illiterate. Oftentimes, surveys had to be read and filled out by a fellow farmer or surveyor. This

could be due to a variety of factors, but is most likely related to the fact that 42.9% of farmers surveyed had received no formal education, and 64.5% had not completed primary school. This is a significant obstacle in the education and use of pesticides. Most pesticides come with only written instructions, and many calculations are required to dilute and combine chemicals. In addition, oftentimes the instructions and precautionary warnings are in English or other foreign languages, which even literate and educated farmers would struggle to interpret. A full understanding of pesticides and their implications is difficult without comprehensive instructions. Thus, effective training would best be conducted orally and by physical demonstration.

Almost all farmers reported having a family history of farming. This, combined with the high average of 18 years experience in agriculture, creates the assumption that many of the farmers use practices well established over the years by personal experience as well as through knowledge passed down from previous generations. This also indicates that if training can be executed in an efficient manner that improves current practices, this information might be passed on to future generations. It is also necessary to understand that for 95% of the farmers, farming is their sole source of income. The ability for their land to have high crops yields is vital to their livelihood. Crop failure from the absence of pesticides would take a large toll on their finances. Thus, it seems that mostly all farmers with the ability to buy pesticides do so. They may not have the option to consider their health or the health of the environment in this decision, as it is directly impacting their own survival.

ii. Rural vs. Peri-Urban

When the data was separated into rural and urban communities, some major differences in even the demographics of such populations appeared. Lack of education seemed to be more of an issue in rural areas than peri-urban areas where percentages of people receiving no formal schooling were 47% and 32%, respectively. Rural populations had an average of four years schooling, while peri-urban population had an average of five. This difference is significant in terms of both current pesticide use and effective methods of training. It can be inferred that rural population have higher numbers of illiterate farmers, making directions and proper calculations for pesticide application harder to follow.

Farmers in rural areas also reported more family history of farming, which correlated to a higher percentage that farmed as their sole source of income. These elevated percentages in rural

areas possibly stem from the fewer job alternatives available, whereas peri-urban farmers located close to cities have more employment opportunities nearby.

iii. Rain-Fed vs. Irrigated

Most of the differences that were observed between the rural farmers and peri-urban farmers were similar to the differences observed between farmers on rain-fed land and irrigated land. This is most likely due to that fact that almost all of the rain-fed farmlands were also located in rural areas and irrigated lands were typically in peri-urban. However, it was observed that differences of demographics between farmers on rain-fed and irrigated land were less stark than the differences between rural and peri-urban farmers. For example, farmers on both rain-fed and irrigated lands had the same average of 4.1 years of schooling, showing that where a farmer lived, rural or peri-urban, was influential than what type of field they farmed on. Therefore, it can be inferred that rain-fed vs. irrigated had little effect on the demographics of the people, and that the differences that were seen in these categories were most influenced by the farms existing in primarily the same rural and peri-urban distinctions.

II. Pesticide Use by Pemba Island Farmers

i. Total Survey Sample

Pesticide use on Pemba Island was found to be widespread and considerably high for subsistence and small-scale farms, with 53.2% of farmers reporting that they used pesticides on their crops. The most common pesticides used were Rogol, Satunil, Certified, Base, Thionex, System, and Dursban, but many others were recorded or observed for sale. These will be discussed and classified later. Almost half of the farmers surveyed did not know the names or types of the pesticides they were using, which might be a cause for their misuse and implies a general lack of education about pesticides.

The majority of the farmers applied pesticides during two periods, both during the rainy seasons from October to November, and March to May. The pesticide retailers also stated that their highest selling seasons of pesticides occurred during those times of the year. The high use of pesticides during the rainy seasons enhances the likelihood of chemical pollution in the environment, as it introduces an effective vector for chemical transport. Runoff from the rains transports chemicals used on the farms to fragile marine ecosystems not adapted to the heavy toxins found in pesticides. Furthermore, the pesticides can contaminate groundwater resources

that entire communities rely on for consumption. Without careful application, the risk for negative impacts on the surrounding environment greatly increases during this time.

On average, farmers spent Tsh 17,219 per year on pesticides, amounting to a good portion of a farmer's yearly income. Most indicated that when buying pesticides, effectiveness was the most important quality sought after, followed by availability and then cost. These data convey the importance of pesticides to farmers on Pemba Island, who generally are poor and spend their money only on what they feel is absolutely pertinent.

Usually the highest contamination levels occur through improper storage. However, the issue of appropriate pesticide storage was less significant than anticipated. 57.4% of farmers did not store their pesticides, using them to completion upon purchase. Most of the farmers who did store their pesticides reported storing them on their farms in a communal storage shed that appeared protected from heavy rains and away from children and animals. Despite the fact that the majority of respondents did not store their pesticides or stored them in an appropriate manner, there was still a statistically significant group of farmers who reported pesticide storage inside the home, at 12.2%. Thus, storage problems still exist and require attention. Furthermore, while most farmers reported disposing of their pesticide containers after use, a small population reported using pesticide containers for food and water, affecting not only themselves but also their families. In addition, pesticide bottles were observed in use at public boreholes, suggesting that while the farmers themselves may not reuse them for food and water, other townspeople may be doing so. Ultimately, it can be inferred that contamination via pesticide storage and disposal are not the most pressing issues facing the farms surveyed, but should not be ignored outright.

In addition to finding a high use of pesticides on the island, it was also found that little protective gear was worn during application. 21.3% of farmers admitted to wearing no protective clothing or equipment, and 18.9% reported only wearing a long sleeve shirt and pants. Fewer than 10% of the farmers surveyed reported using a mask, goggles, or respiratory protection. Only two farmers reported wearing all of the suggested protective equipment, which means only about 1% of farmers on Pemba Island apply pesticides with appropriate equipment. Most farmers only wear one or two of the suggested items for protection during pesticide application. Interestingly, very few attributed their lack of protective gear to discomfort or dislike, but rather its high cost or lack of availability. This lack of protective gear causes a high

risk for acute pesticide poisoning. The effects of this can be seen in the significant percentage of farmers reporting symptoms of acute pesticide poisoning. 53.1% reported symptoms, although it is very likely that these numbers are low, as pesticide poisoning is widely misunderstood and lacks a concrete definition.

ii. Rural vs. Peri-Urban

Stark differences were noted in pesticide use between peri-urban and rural farming communities. Peri-urban farmers used pesticides more than rural farmers by almost three-fold, with 97.6% and 35.9% reporting pesticide use, respectively. This disparity is most likely due to the availability of pesticides, as most pesticides are sold primarily in the urban centers of Mkoani, Wete and Chake Chake, far from rural villages. Cost, too, probably plays a role, as rural villages typically have fewer resources and less wealth. The cost of pesticides is more manageable for peri-urban farmers, who may have alternative sources of income and a greater influx of income. Lastly, this also may be attributed to the education level of the farmers; peri-urban farmers had more education and probably understand the benefits of pesticide use more so than rural farmers. Relative wealth can also be seen through different methods of pesticide application. 62.8% of rural farmers applied pesticides by hand as opposed to using knapsack sprayers, favored by peri-urban farmers. Knapsack sprayers cost over Tsh 35,000 and may not be an option for many rural farmers. Surprisingly, rural farmers spent more overall on pesticides than peri-urban farmers, spending Tsh 23,682 a year. However, this is likely due to larger farm sizes.

Over half of the farming population in both rural and peri-urban farms bought pesticides at the time they need them, meaning most did not report storing them. For those who did store their pesticides, it was more common for rural people to store pesticides in their homes. This may be related to education level, as farmers trained to work with pesticides would know not to do so. No peri-urban farmers reported reusing pesticide containers for food or water, but a small population of rural farmers reported this reuse. Again, this is most likely the result of a lack of pesticide training in rural areas, as educational outreach seems only to have reached more developed areas. From this data, it is reasonable to conclude that chemical contamination from pesticide storage appears to be a greater concern in rural areas than in peri-urban areas. This observation is strengthened by the statistic that under half of the population of farmers in rural communities reported proper disposal of pesticide containers.

Twice as many farmers on peri-urban farms reported abstaining from wearing protective gear than rural farmers. This statistic seems contradictory to the previous assumptions about lack of pesticide training and education, however when considered within the context of rural pesticide use, makes sense. Over a third of the protective gear reported by rural farmers were gloves, which is understandable given a large portion of rural farmers applied pesticides by hand. However, half of those farmers wore only gloves and no other protective equipment during application. Essentially, many farmers, on both rural and peri-urban farms, wear only the most basic levels of protective gear. Again, this leads to high levels of reported pesticide poisoning. Low levels of protective gear especially on peri-urban farms correlate with an elevated level of pesticide poisoning symptoms, which will likely continue to afflict farmers until the root cause can be addressed.

iii. Rain-Fed vs. Irrigated

There are many similarities in regards to pesticide use between rain-fed and irrigated farms and rural and peri-urban farms as many of the communities overlap. Still, some notable statistics should be mentioned. 100% of farmers on irrigated farms used pesticides, whereas only a quarter of rain-fed farmers used pesticides. This suggests multiple differences between the two categories, including possible economic disparities between farmers in each location or perhaps just different farming techniques. The majority of farmers on rain-fed farms were unaware of the names of the pesticides they were using, which again indicates a lack of information and education regarding pesticides in the area.

Farmers on rain-fed farms spent more on pesticides than those on irrigated farms, probably due to larger plot sizes. In addition, rain-fed crops are more vulnerable crops, as they rely on natural processes for successful growth. Thus, they require more protection from external threats such as parasitic insects or fungi.

Much like rural farms, rain-fed farms face more storage and contamination issues than their counterpart. More people reported storage of used pesticide containers in the home. However, farmers on irrigated farms reported a much higher level of pesticide container burial as a means of disposal. Burial of pesticide containers can be done in a way that minimizes its environmental impact, but if not done properly it can lead to direct chemical contamination into the soil and groundwater. Given the lack of education and training, it can be assumed that many farmers are not taking contamination into account. Additionally, farmers on both irrigated and

rain-fed farms were observed washing clothing in the irrigation canals or nearby streams, which means that pesticide contamination is still a very real concern.

There was a much higher use of protective equipment by rain-fed farmers compared to farmers on irrigated farm. Again, this is probably due to the differing methods of application and does not mean that farmers on rain-fed farms wore all suggested items of protective equipment. This correlated to a slightly higher reporting of acute pesticide poisoning symptoms, but the levels of reported symptoms were so close that it probably implies a similar lack of preventative equipment in both locations.

III. Identification and Classification of Pesticides Used

Of the pesticides listed by farmers, the most common chemical type was organophosphorous. Organophosphorous have a low persistence in the environment, degrading naturally in a matter of weeks. From an environmental standpoint, these chemicals are preferable, as their long term effects on ecosystems and animal populations is minimal. However, organophosphorouses are much more acutely toxic in comparison to other chemical types, putting farmers at risk of poisoning during application. This, in addition to the fact that most farmers on Pemba Island do not wear the appropriate safety equipment, are probably linked to the high levels of pesticide poisoning cases reported. The use of organophosphorouses reported illuminates the need for more educational outreach about the serious health effects of pesticide application.

Farmers reported only two pesticides that were organochlorides, but they were reported in high numbers. This type of chemical holds more serious consequences for negative environmental impacts in the long term. Organochlorides are highly persistant; the active ingredient in Thionex and Thiodan is not degraded until over 14 years after application. This will lead to environmental problems in the future, and likely already has had some effect on the surrounding habitats. On a place like Pemba Island, with valuable endemic species and clearly limited natural resources, this can pose problems to ecosystem health. Organochlorides have been known to cause problems such as bioaccumulation, sterility, and mutations, adversely affecting species populations.

Notably, three of the pesticides listed, Systam, Thionex and Furadan, have either been banned or discontinued as of 1994. Due to the fact that it is highly unlikely for brands to reenter the market, these are most likely chemical leftovers still making their way out of circulation. Not

surprisingly, these were some of the pesticides with the highest levels of toxicity. Furadan, in particular, is listed as highly hazardous, and can be fatal if swallowed or if it comes in contact with skin. Considering how little protective gear farmers on Pemba Island wear, this poses a great concern for their health and wellbeing. It could indicate that they are unaware of the health consequences caused by this chemical, again demonstrating the need for legible instructions and further education. Additionally, Furadan is strong enough to kill animals aside from the targeted pest. Without careful application, it could decimate populations of fish, birds or essentially any other vulnerable animal. These chemicals again raise concern for the safety of the farmers and the state of the environment.

IV. Pesticide Awareness and Education of Pemba Island Farmers

i. Total Survey Sample

Only 16.9% of the farmers surveyed stated that they had received any training or education about pesticides. This leaves a large portion of the farmers in the dark about some of the more serious consequences of pesticide use. Without knowing all of the effects that pesticides can have to both human health and the environment, it is hard for these farmers to be expected to place the appropriate amount of importance on using these chemicals properly. With almost half of the farmers surveyed using pesticides and only a small amount with education and training, it can be assumed that some of the misuses that have been discovered stem from this lack of knowledge. Another important aspect to consider is that most information available to these farmers currently comes in the form of written directions and information, which is not useful for over half of the population that has been found to be illiterate.

Though currently only 57.3% of farmers surveyed on Pemba Island use pesticides, 92% of the farmers indicated that pesticides were necessary for the success of a crop. With almost all of the farmers surveyed believing that pesticides do help to increase crop yield and protect crops from pests, it can be assumed that those farmers who are not using pesticides currently are doing so because of either high expense or unavailability. This high percentage of farmers who felt that pesticides were necessary could be a result of the vulnerable crops that are being grown on Pemba Island such as rice and tomatoes that are targets for many pests. Pesticide use in the future can be expected to increase if more farmers gain the means and capital for obtaining such chemicals.

Understanding of the adverse human health effects of pesticides appeared to be more understood than the adverse effects they can cause to the environment. Nearly 90% of the population surveyed indicated that they thought pesticides were dangerous to human health. However, of those using pesticides, there were still many who reported not wearing any protective gear at all. Since the surveys showed farmers have managed to learn that pesticides are dangerous to human health, it suggests that their lack of protective gear stems more from the lack of ability to obtain such gear than a lack of understanding about the effects of pesticides. In interviews, farmers expressed that gear, such as gloves or rubber boots, were out of their feasible price range. On Pemba Island, boots can be purchased for Tsh 12,500, gloves for Tsh 100 and masks for Tsh 1,000; combined, they cost more than many farmers spent per year on pesticides alone. In Swahili, there is a term for someone who is forced into environmental exploitation as a means of survival, called *muhali.* It is possible that this term could apply to many of the farmers, who need pesticides for adequate crop yield and in turn, a steady income. The acute effects of pesticide poisoning may not be strong enough to deter farmers from their usual routine of application. Since long-term effects are not well known or well perceived, they are easy to ignore in the short-term. However, such frequent exposure without protective equipment could lead to serious chronic illnesses.

In regards to understanding the effects of the environment, almost 15% of the population surveyed felt that pesticides were not harmful. The lessened concern over effects to the environment could stem from the fact that such negative impacts are not perceived directly as compared to the human health impacts. With pesticide use occurring frequently during the rainy seasons it is essential that these farmers understand the adverse effects these chemicals can have on the surrounding environment if not used properly. Without this understanding, it is hard to realize that importance of proper application.

ii. Rural vs. Peri-Urban

Rural communities reported receiving significantly less pesticide education and training, 6.5%, as compared to the 44% received by peri-urban communities. Though neither of these percentages is enough, it is obvious that effective educational outreach on pesticides to rural farmers is seriously lacking. With this being noted it is no surprise that almost all peri-urban farmers recognized that pesticides posed serious threats to human health and the environment. For the most part, rural farmers recognized that pesticides provided some kind of risk to human

health, yet over 15% felt they were not harmful to the environment whatsoever. This dangerous disconnect between rural populations and environmental consequences of pesticide raises alarm for these farmers who are relying on their environment more directly than peri-urban farmers. These rural communities will most likely feel the negative consequences of improper use first, and will suffer the most due to the heavy reliance on thriving surrounding ecosystems for food, shelter and livelihood.

It should also be noted that 71.4% of peri-urban farmers stated seeing an increasing trend in pesticides in the past ten years, while only 27.2% of rural farmers reported this same trend. Since pesticide use was much higher with peri-urban farmers, it would make more sense that they would see such an increase in the past years.

iii. Rain-Fed vs. Irrigated

33.8% of the farmers on irrigated land had received pesticide education or training, whereas only 5.8% of rain-fed farmers reported such training. This education correlated with slightly higher percentages of farmers on irrigated lands reporting pesticides were harmful to both human health and the environment.

The starkest difference between farmers on rain-fed and irrigated lands was their responses when asked what the pesticide trends had been in the last 10 years. An overwhelming majority of farmers on irrigated lands felt that pesticide use had increased, while nearly half of the rain-fed farmers stated that they did not know. This would mean that pesticides have probably been increasing on irrigated farms, where farmers have the ability to make such purchases. On rain-fed farms, farmers largely still farm without pesticides, and have therefore not witnessed such an increase in use.

V. Information Sessions for Farmers

Based on data collected and interactions with the farmers of Pemba Island, it was clear that they were not intentionally hurting themselves or their environment through improper practices, and were very interested in learning more about appropriate methods of application and storage. However, cost and availability still remained obstacles and thwarted their efforts. Four brief informational sessions were held for farmers in order to spread awareness and promote good pesticide practices.

The results indicated that the greatest use of pesticides took place on peri-urban and irrigated farms. Thus, it was determined that the farming communities of Weni and Mangwena

had the greatest need for pesticide education and so the focus of the information sessions was targeted at correcting their practices. The other locations, Pondeani and Kipapo, were chosen based on the ease of facilitation.

To address some of the central issues around pesticide use and awareness on Pemba Island, visual educational posters were made as well as a supplement to the optional brief training and information sessions.[4] The posters included sketches that helped to demonstrate proper protective gear, proper storage, safe application and appropriate disposal. A small donation of 12 pairs of boots, 20 masks, and 20 gloves were made to the communities of Weni and Mangwena in hopes that they would share the materials and wear them during pesticide application in the future.

VI. Sources of Error

The possible sources of error included the high illiteracy rates that required assistance from either colleagues or surveyors, which could have influenced answers and skewed data. Some handwriting or answers were difficult to interpret and were left to the discretion of an outside source. The sample area was small and only willing farmers were surveyed. Surveys from the previous pilot study were included in the data, with questions that had been altered being dropped. This meant that some questions had a larger sample size than others. Some of the questions were more difficult for farmers to answer. Questions such as "how much do you spend annually on pesticides?" and "how many hectares is your farm?" were given very rough estimates by farmers and may have not accurately represented the farming population of Pemba Island.

Conclusion

The aim of this study is not to discourage the use of pesticides, but rather to advocate their proper usage. The effects of a failing crop would be devastating to subsistence farmers living in places like Pemba Island, thus the option of eliminating pesticides is improbable. However, the consequences of continuing use, as demonstrated in the survey, could be equally devastating. Fragile environments, such as mangrove forests or inter-tidal zones, cannot withstand the strong chemicals emitted in runoff from agricultural crops for very long. Pemba Islanders are at risk of losing more than just the natural beauty of their island; they risk losing

[4] See Appendix for posters.

valuable resources that they rely on for food, shelter, and livelihood. In addition, they risk bringing harm to themselves and their families. Chronic exposure can lead to serious health issues that are not worth the short-term benefits of pesticides. If the improper use of pesticides continues, human and environmental health issues can be anticipated. Yet, if used properly and with the necessary gear, negative effects to both the surrounding environment and population can be minimal.

More education needs to be directed towards farmers in a manner that is effective for a wide population, such as physical demonstrations with visual supplements. Proper equipment needs to be more readily available in order to protect farmers and to assist them in applying pesticides in a safe and efficient manner. Lastly, minimal aid from a non-governmental organization would greatly assist the farmers in purchasing equipment such as boots, gloves and masks that would drastically reduce cases of acute pesticide poisoning and minimize chronic effects in the future.

Recommendations

For replication of this study in the future, a few adjustments should be made. An unbiased translator would greatly aid the communication between surveyors and farmers without influencing their responses. Also, individual interviews with the farmers or a select group of farmers would help to limit influences on each other's answers. An increased sample size would also increase the legitimacy of this study, as well as a more extensive survey that looked even further into pesticide use and perceptions.

This study also prompts further areas for investigation and action. Certainly, the brief training sessions offered in part with this survey were not extensive enough to reach a significant number of farmers on Pemba Island. Future studies could focus on creating an effective and more in depth seminars for pesticide users. More interviews could be conducted with pesticide retailers to investigate the marketing and economic factors behind pesticide use, and interviews with government officials could provide insight about the government's role in pesticide use and distribution. Another study could look at pesticide use on Pemba Island with a more scientific scope, examining contamination levels, vector transport, and effects on tropical species. Lastly, a study could be done to research possible sustainable pesticide alternatives and their feasibility in this environment.

Works Cited

Anthony, Robert G., et al. "Environmental Contaminants in Bald Eagles in the Columbia River Estuary." *The Journal of Wildlife Management* 57.1 (1993): 10-19.

Khatib, Ali, et al. "Country Report: Tanzania – Zanzibar." (1998): 1-10.

Kishimba, M.A., et al. "The Status of Pesticide Pollution in Tanzania." *Talanta* 64.1 (2004): 48-53. Print.

Koh, David and J. Jeyaratnam. "Pesticides Hazards in Developing Countries." *Science of The Total Environment* 188. Supplement 1 (1996) S78-85. Print.

Matthews, G., T. Wiles and P. Baleguel. "A Survey of Pesticide Application in Cameroon." *Crop Protection* 22.5 (2003): 707-714. Print.

Ngowi, A.V.F, et al. "Smallholder vegetable farmers in Northern Tanzania: Pesticides use, practices, perceptions, cost, and health effects." 1617-1624.

Ondieki, John J. "The current state of pesticide management in Sub-Saharan Africa." *Science of the Total Environment* 188. Supplement 1 (1996): S30-34. Print.

Pal, S.K. & S.K. Das Gupta. "Pesticide Application: Skill Development Series No. 17." *International Crops Research Institute for the Semi-Arid Tropics* (1996). 1-30.

Rama, D.B.K., & K. Jaga. "Pesticide exposure and cholinesterase levels among farm workers in the Republic of South Africa." *The Science of the Total Environment* 122.3 (1992): 315-9. Print.

Sethunathan, N. "Biodegradation of Pesticides in Tropical Rice Ecosystems." *Ecotoxicology and Climate* 5.2 (1989): 247-264.

Stadlinger, Nadja. "Pesticide Management in Tanzania: Interview Studies on Use, Sales, and Import." Doctoral Thesis, University of Stockholm, Sweden. 4-20.

Mohammad, Amour. Plant Protection Services. Personal Communication, 2010.

Appendix

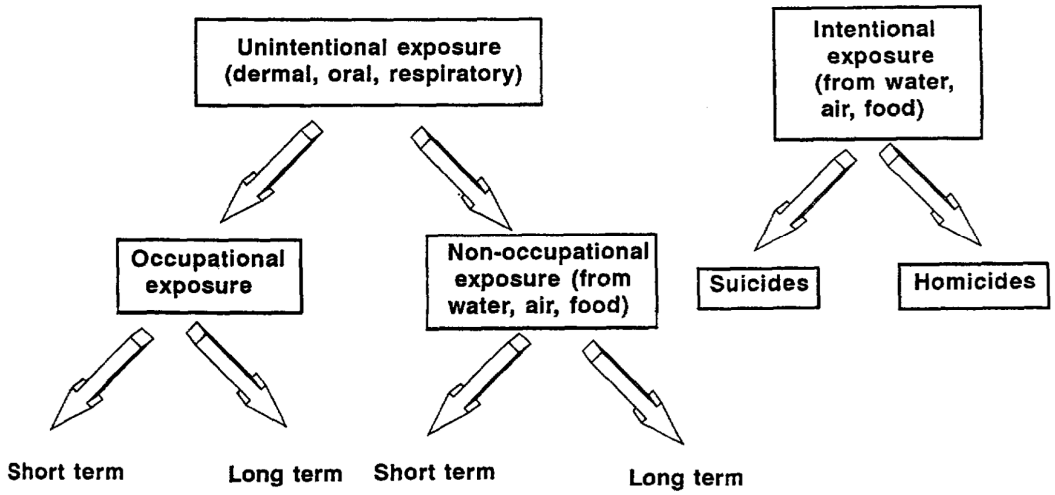


Figure 1 – Types of exposure to pesticides

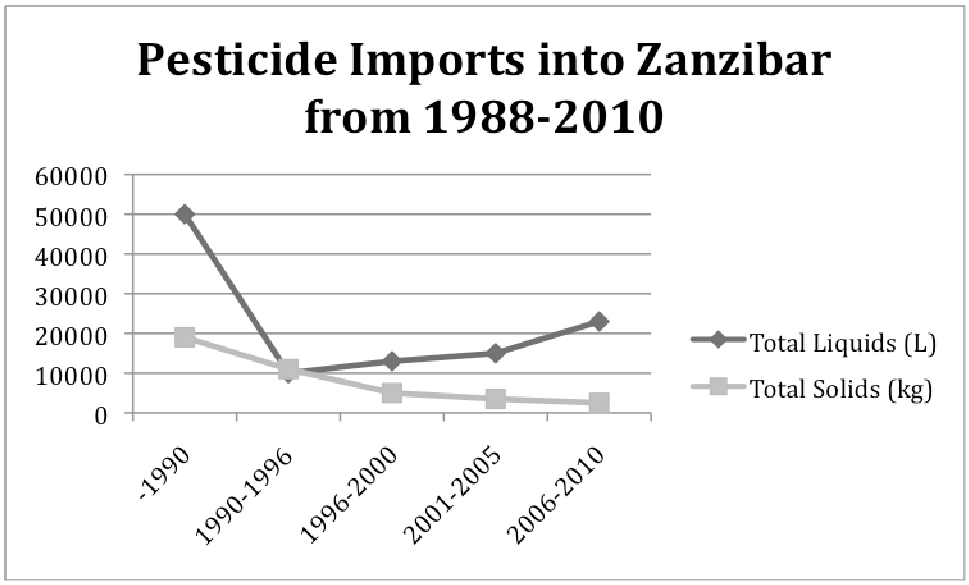


Figure 2 – Pesticide Imports by Plant Protection into Zanzibar from 1988-2010

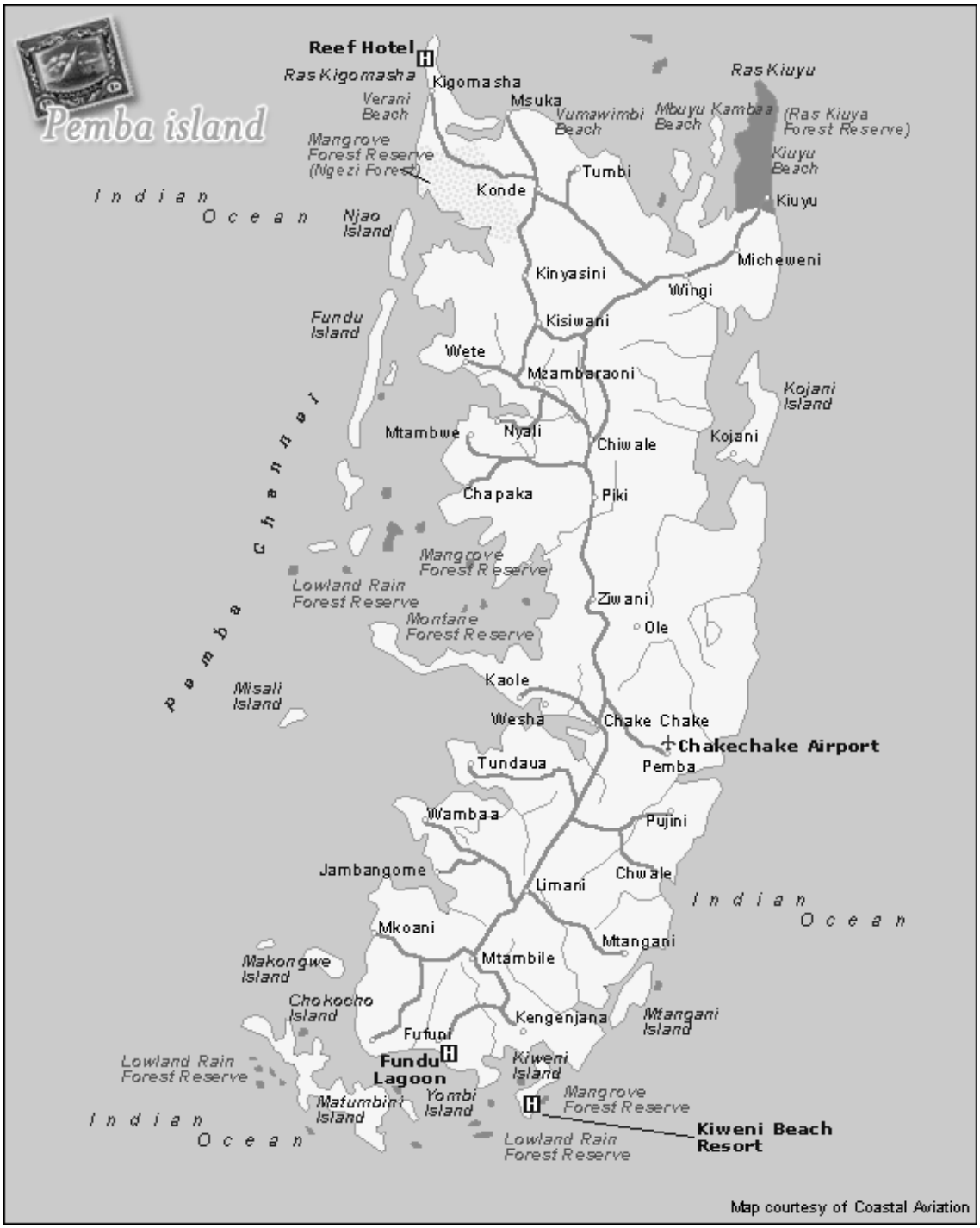


Figure 3 – Map of Pemba Island

SWALI KWA WAKULIMA

Habari Binafsi:

1. Unaitwa nani? :_____
2. Unamiaka mingapi?: _____
3. Mwanaume _____ Mwanamke_____

4. Umelima miaka mingapi?: _____

5. Wazazi wako walikuwa wakulima?: Ndiyo_____ Hapana___

6. Je kilimo ni chanzo kikua cha pato lako?: Ndiyo_____ Hapana_____

7. Je una ekari au hektari ngapi za shamba?: _____

8. Unalima zao gani?: _____

_____

_____

9. Umesoma mpaka darasa la ngapi?: _____

Maswali ya maduwa ya kuulia wadudu kwa ujumla:

1. Je unatumia dawa za kuulia wadudu?: Ndiyo_____au Hapana_____
2. Ikiwa ndiyo, nitajie majina ya dawa za kuulia wadudu unazo tumia
    a. _____
    b. _____
    c. _____
    d. _____
    e. _____
    f. _____

3. Wakati gani wa mwaka ambao unatumia dawa za kuulia wadudu? _____

4. Mara ngapi unatuumia dawa za kuulia wadudu kwa msimu? _____

5. Unatumia pesa ngapi kwa kununulia dawa za kuulia wadudu kwa mwaka? _____

6. Je umewahi kupata mafunzo ya elimu ya dawa za kuulia wadudu?

Ndiyo_____ Hapana_____

7. Je unahifadhi wapi madawa ya kuulia wadudu?

a) nymbani b) shambani c) sihifadhi (ninanunua na kutumia) d) nyengi nezo

8. Vipi unatumia madawa ya kuulia wadudu katika shamba lako?

a) kwa mikono b) tangi la dawa e) sijui f) nyengi nezo _____

9. Mnavaa nini wakati wa kupiga dawa za kuulia wadudu:

_____ Suruali refu na shati la mikono mirefu _____ Miwani ya kukinga macho

_____ Ngao ya kukinga uso _____ Glovu

_____ Vyombo vya kukinga pumzi _____ Viatu vya raba

10. Ni sababu zipi zinazokufanya usivie mavazi ya kujikinga na mdawa za kuulia wadudu?

a) hazipatikani b) ghali c) sipendi d) nyengi nezo_____

11. Wewe binafsi pamoja na mkulima mwenzako munao uzo efu wa kupata maradhi baada ya kutumia madawa ya wadudu?

_____ Ndiyo _____ Hapana

Ikiwa ndiyo, tafadhali angalia kati ya maradhi haya:

___ Kizunguzungu

___ Kutapika

___ Kuungua

___ Kuwashwa

___ Mengineo (tafadhali elezea) _____

1. Kwa vipi unadhani dawa za kuulia wadudu ni muhimu?

a) sio lazima/ sio muhimo b) kwa kiasi ni muhimu c) ni muhimu sana

2. Kwa kiasi gani dawa za kuulia wadudu zinaweza kuhatarisha afya ya mwanadamu?

a) sio hatari b) ni hatari kidogo c) ni hitari sana

3. mabaya yepi yanayoweza kuletwa na dawa za kuulia wadudu katika mazingira yenu?

a) sio mbaya b) mbaya kidogo c) mbaya sana

4. Kwa vipi matumizi ya dawa za kuulia wadudu yamebadilika kwa kipindi cha miaka kumi iliopita katika kisiwa cha Pemba?

a) imeongezeka b) imepungua c) haijabadalika d) sijui

5. Ni mazao yepi mbayo yanahitaji madawa ya kuulia wadudu ili yaweze kuota vizuri?

_____

6. Unaponunua madawa ya kuulia wadudu ni nini kinachokuongoza ununue dawa gani?

a) Gharama b) Upatikanaji c) Uborawake d) Nyinginezo

7. Unafanya nini makopo ya madawa ya kuulia wadudu?

a) ninatupa

b) ninatumia kwa kuweka madawa ya kuulia wadudu tena

c) ninatumia kwa kuweka maji ya kunywa, ninaweka chakula

d) nyengi nezo _____

Questionnaire for Pemba Farmers

Background Information:

4. Name:_____

5. Age: _____

6. Male _____ Female_____

4. Years farming:_____

5. Family history of farming?: Yes_____ No___

6. Is farming your only source of income?: Yes____ No____

7.How many acres/hectares do you own?: _____

8. What is being farmed?:

_____

_____

9. Years of Schooling?: _____

Pesticides:

3. Do you use any pesticides? Yes_____ No_____

4. If yes, what are the names of the pesticides used on your crops?

   a. _____

   b. _____

   c. _____

   d. _____

3. What time of the year do you apply pesticides?_____

4. How often do you apply pesticides per season of crop? _____

5. How much money do you spend per year on pesticides? _____

6. Have you completed any training or received any education about pesticides?

Yes_____ No_____

8. Where do you store your pesticides?

a) don't store them b) at home c) on the farm d) other_____

9. How are the pesticides applied?_____

a) by hand b) by knapsack sprayers e) don't know f) other

---

10. Check all of the following protective materials that are worn during the handling and application of pesticides:

(1) Long sleeves and pants_____ (4) Protective eyewear_____

(2) Face protection_____ (5) Gloves_____

(3) Breathing protection_____ (6) Rubber boots_____

11. What is your reason for not wearing any of the previously listed protective gear?

a) not available b) too expensive c) uncomfortable d) other_____

12. Have you or any of your co-workers experienced sickness after an application of pesticides?

Yes_____ No_____

If yes, please check which of the following you/they have felt:

___ Dizziness

___ Nausea

___ Burning

___ Itching

___ Other (please describe)

1. How necessary do you think pesticides are?

a) not necessary b) somewhat necessary c) very necessary

2. How dangerous can pesticides be to human health?

a) not dangerous b) moderately dangerous c) very dangerous

3) How bad are pesticides for the environment?

a) not bad b) sometime bad c) very bad

4. How has pesticide use changed over the last ten years?

a) increased b) decreased c) stayed the same d) don't know

5. What crop(s) require the most pesticides to grow successfully?

_____

6. When you buy pesticides, what determines which you will buy?

a) Cost b) Availability c) Effectiveness d) Other

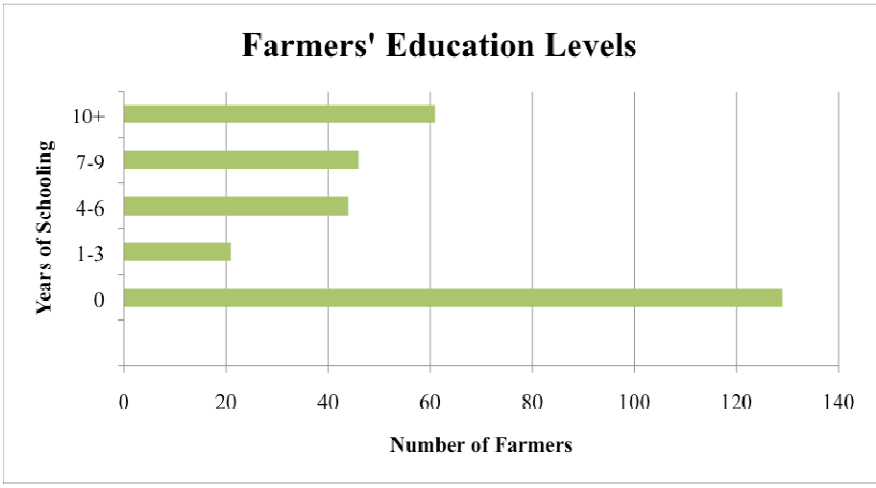
7. What do you do with your empty pesticide containers?

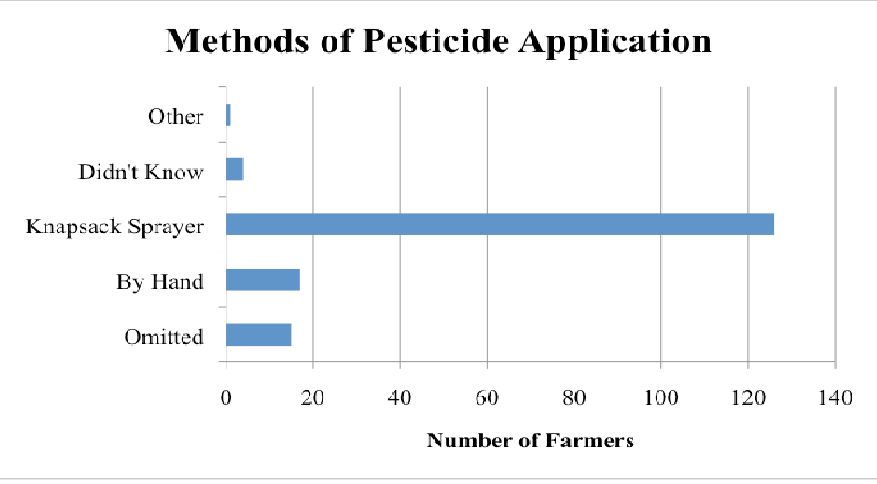
a) Dispose them b) Reuse them for pesticide c) Reuse them for food or drink d) Other

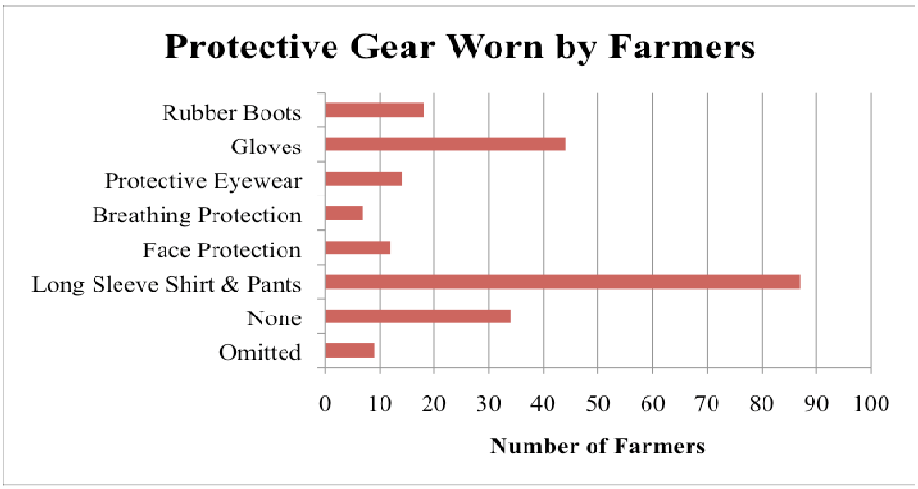
Interview with Amour Mohammad

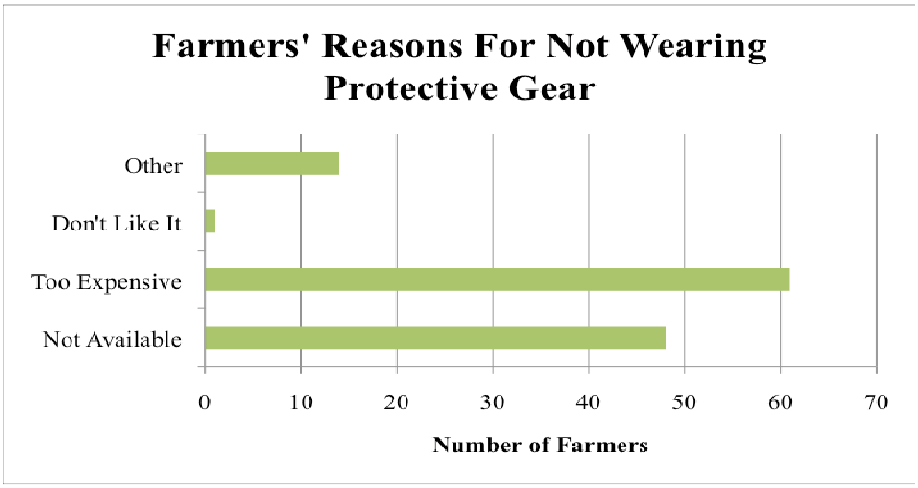
1. When was Plant Protection first begun?
2. What is the goal of Plant Protection?
3. What types of programs does Plant Protection run?
4. When did you start becoming involved with Plant Protection?
5. What are the most common pesticides used in the Zanzibar Archipelago?
6. When are they used?
7. What crops require the most pesticides to grow successfully?
8. How common is it for farmers to use pesticides on their crops?
9. How expensive are pesticides? Can they be purchased easily on Pemba? Who sells them?
10. How much knowledge do most farmers have, in your opinion, about pesticides?
11. Do you think most people are educated about how to properly apply pesticides to crops?
12. Have you seen any negative human health effects from not properly applying pesticides?
13. Have you seen any negative environmental effects from not properly applying pesticides?
14. What do you think needs to be done in order to prevent improper application of pesticides?
15. What do you think is the main reason for improper application of pesticides?
16. Where do most people store their pesticides?
17. How much do economics lead to problems with pesticides?
18. How much does lack of education lead to problems with pesticides?
19. Have you noticed a change in the amount of pesticides used in the last ten years?
20. Have you noticed a change in the application of pesticides in the last ten years?
21. What do you think the best way to educate farmers about pesticides would be?

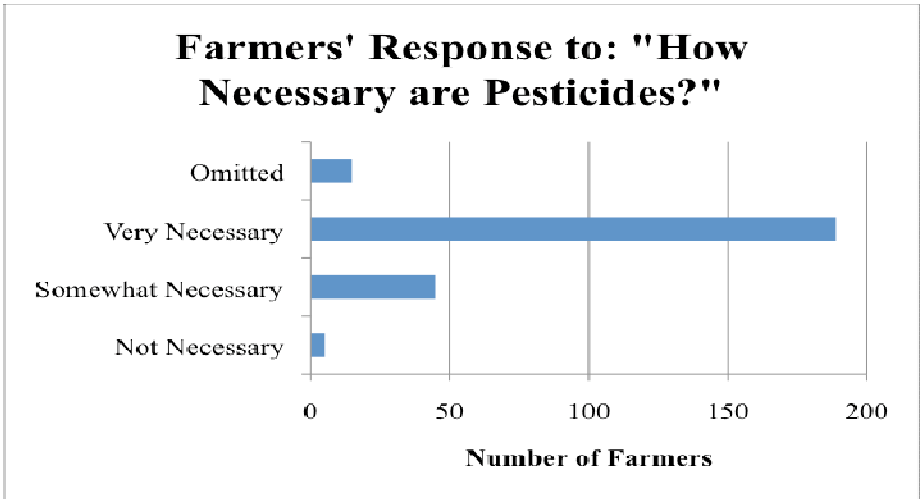
Graphs – Overall

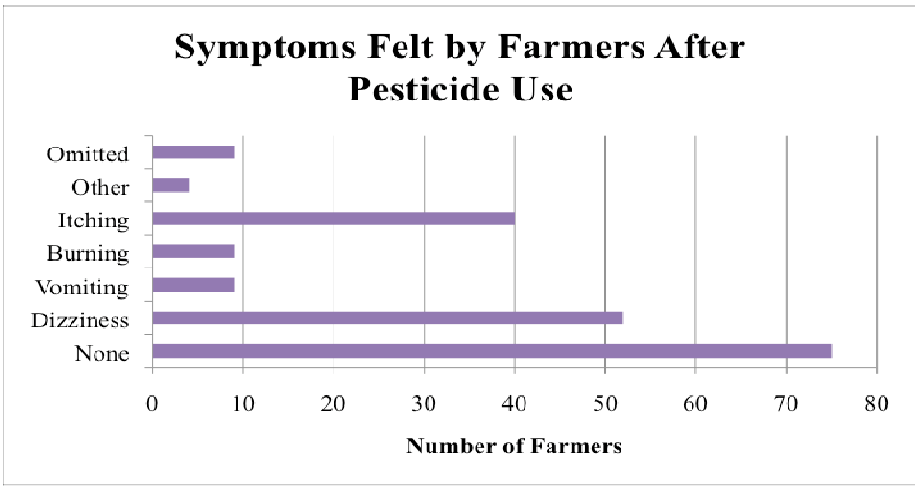


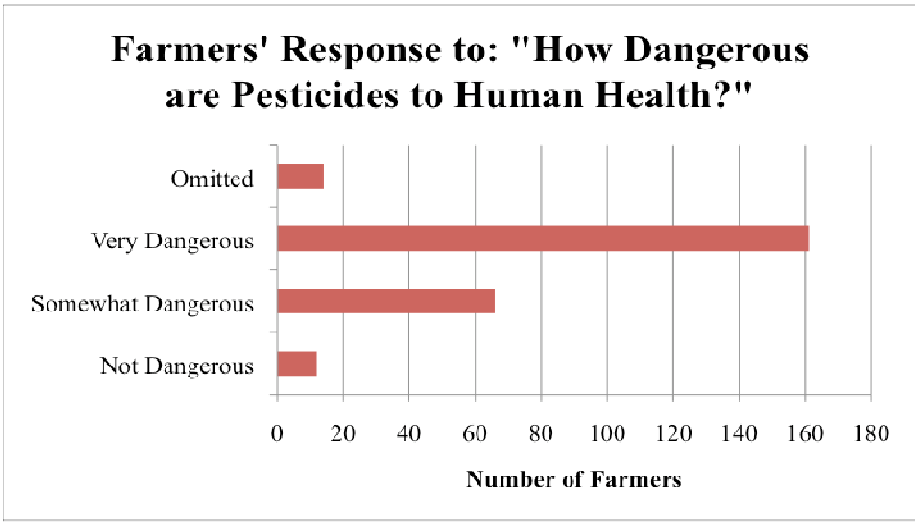


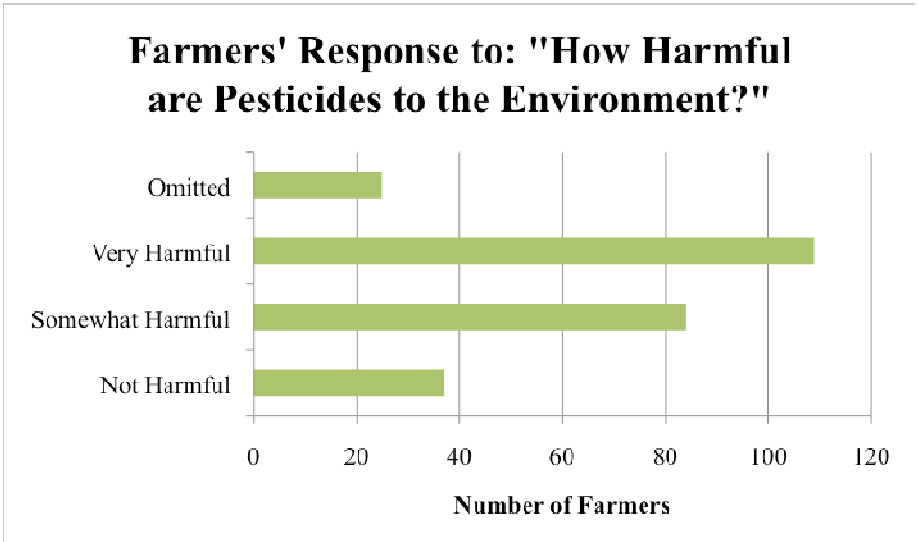

Protective Gear Worn by Farmers
Rubber Boots
Gloves
Protective Eyewear
Breathing Protection
Face Protection
Long Sleeve Shirt & Pants
None
Omitted
0 10 20 30 40 50 60 70 80 90 100
Number of Farmers

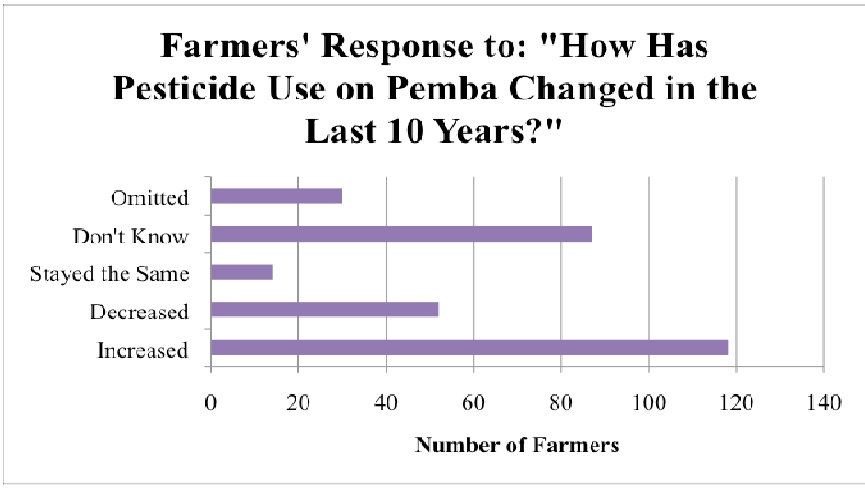

Farmers' Reasons For Not Wearing Protective Gear
Other
Don't Like It
Too Expensive
Not Available
0 10 20 30 40 50 60 70
Number of Farmers

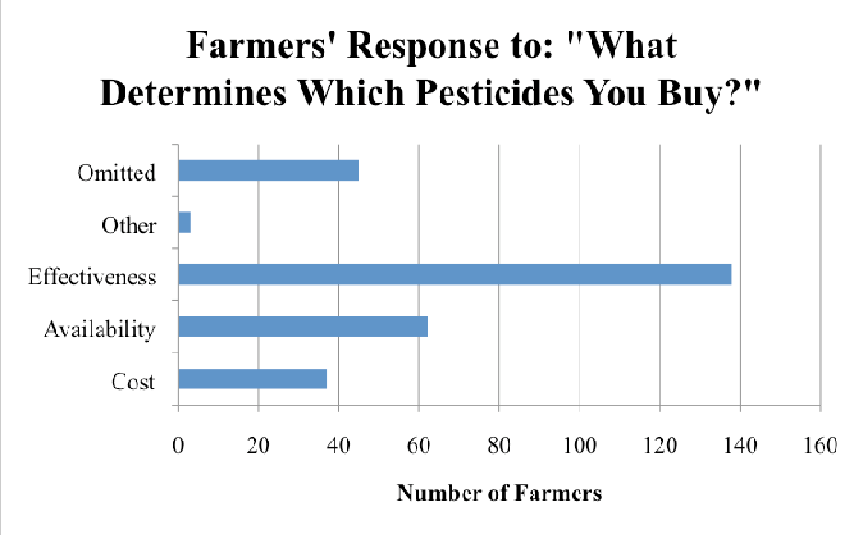

Farmers' Response to: "How Necessary are Pesticides?"
Omitted
Very Necessary
Somewhat Necessary
Not Necessary
0 50 100 150 200
Number of Farmers

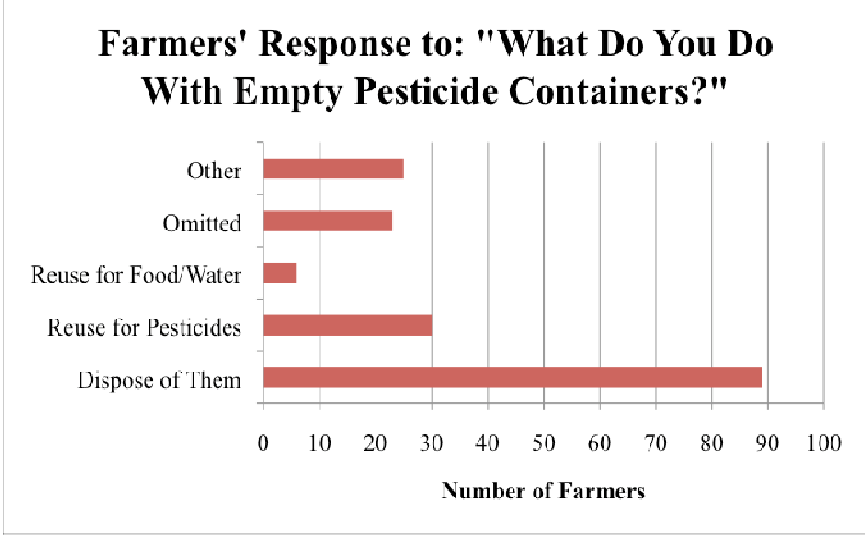

Symptoms Felt by Farmers After Pesticide Use
Omitted
Other
Itching
Burning
Vomiting
Dizziness
None
0
10
20
30
40
50
60
70
80
Number of Farmers


Farmers' Response to: "How Dangerous are Pesticides to Human Health?"
Omitted
Very Dangerous
Somewhat Dangerous
Not Dangerous
0
20
40
60
80
100
120
140
160
180
Number of Farmers

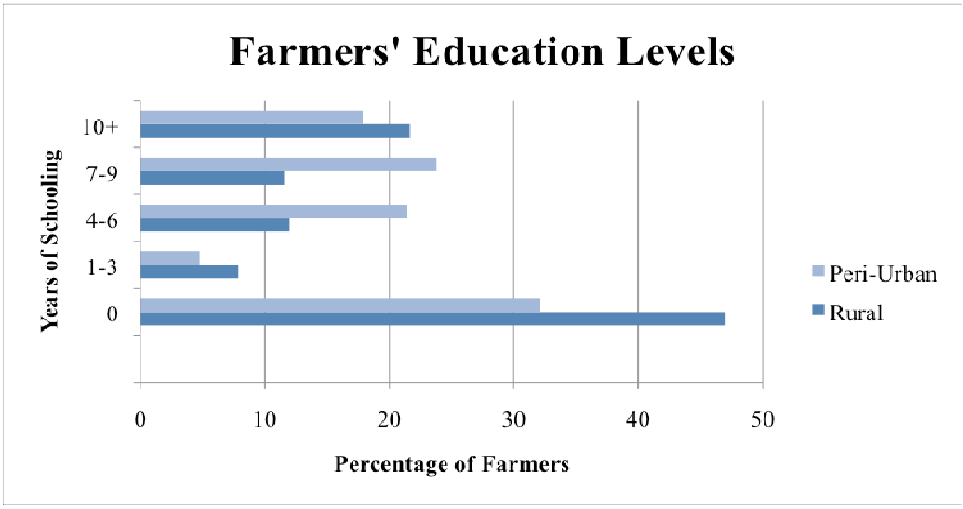

Farmers' Response to: "How Harmful are Pesticides to the Environment?"
Omitted
Very Harmful
Somewhat Harmful
Not Harmful
0
20
40
60
80
100
120
Number of Farmers

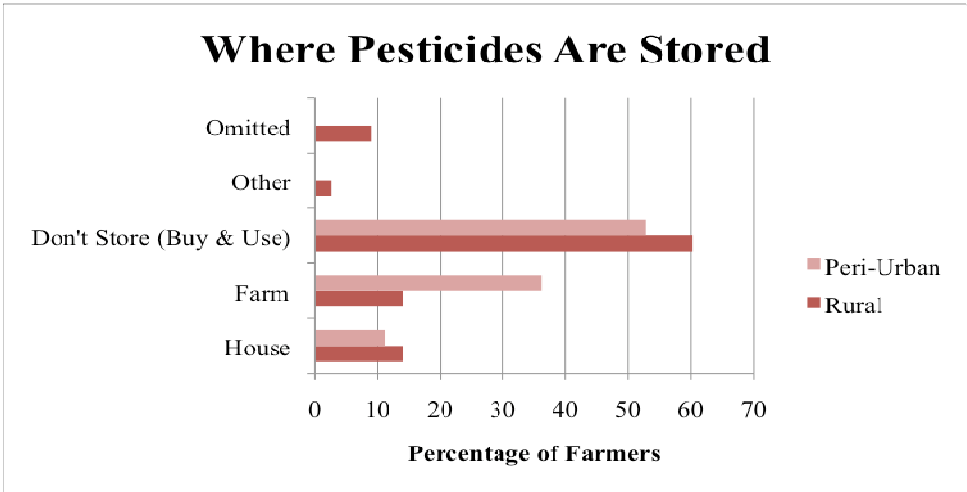

Farmers' Response to: "How Has Pesticide Use on Pemba Changed in the Last 10 Years?"
Omitted
Don't Know
Stayed the Same
Decreased
Increased
0
20
40
60
80
100
120
140
Number of Farmers

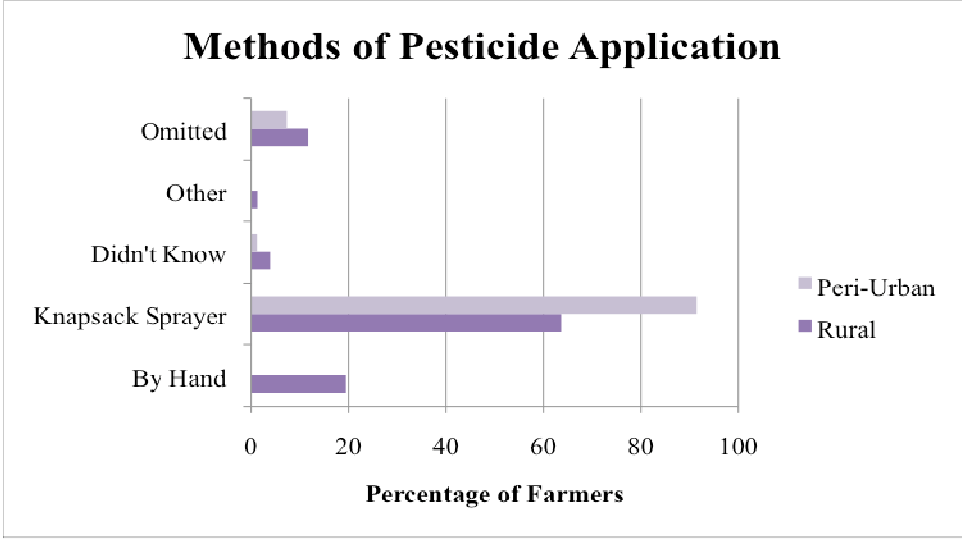

Farmers' Response to: "What Determines Which Pesticides You Buy?"
Omitted
Other
Effectiveness
Availability
Cost
0
20
40
60
80
100
120
140
160
Number of Farmers

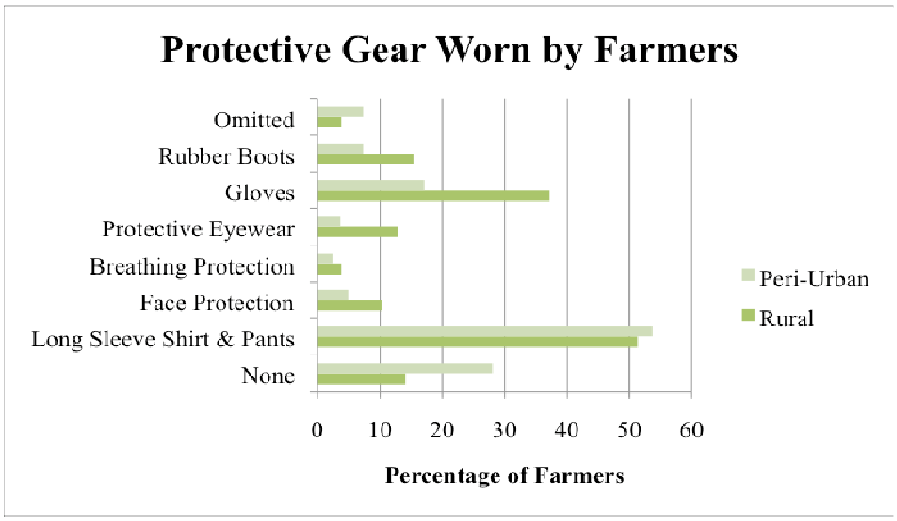

Farmers' Response to: "What Do You Do With Empty Pesticide Containers?"
Other
Omitted
Reuse for Food/Water
Reuse for Pesticides
Dispose of Them
0
10
20
30
40
50
60
70
80
90
100
Number of Farmers

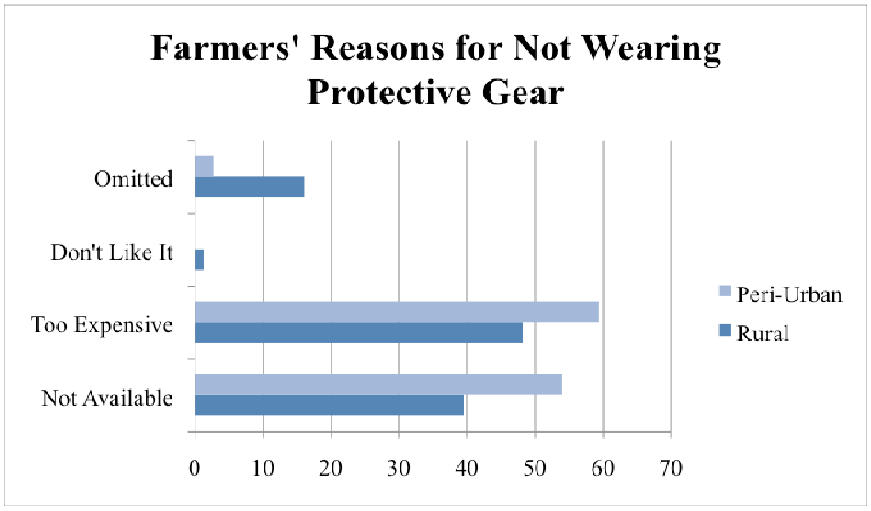
Graphs – Rural vs. Urban

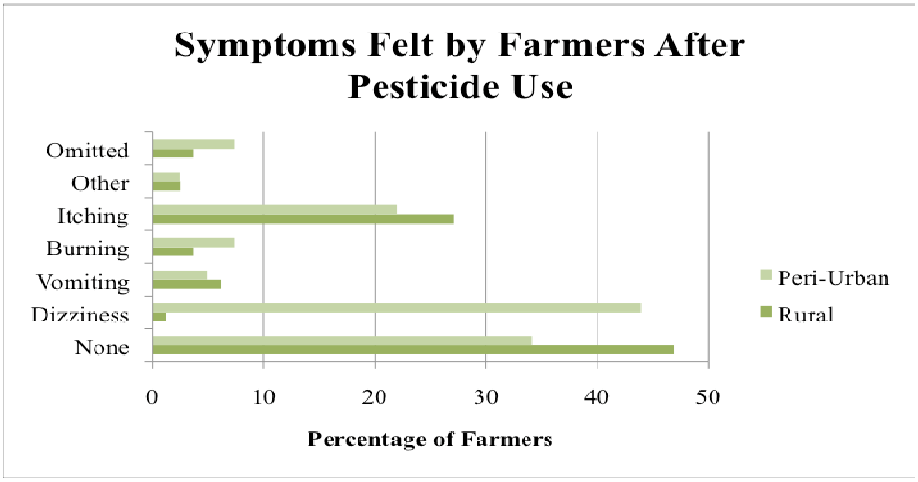


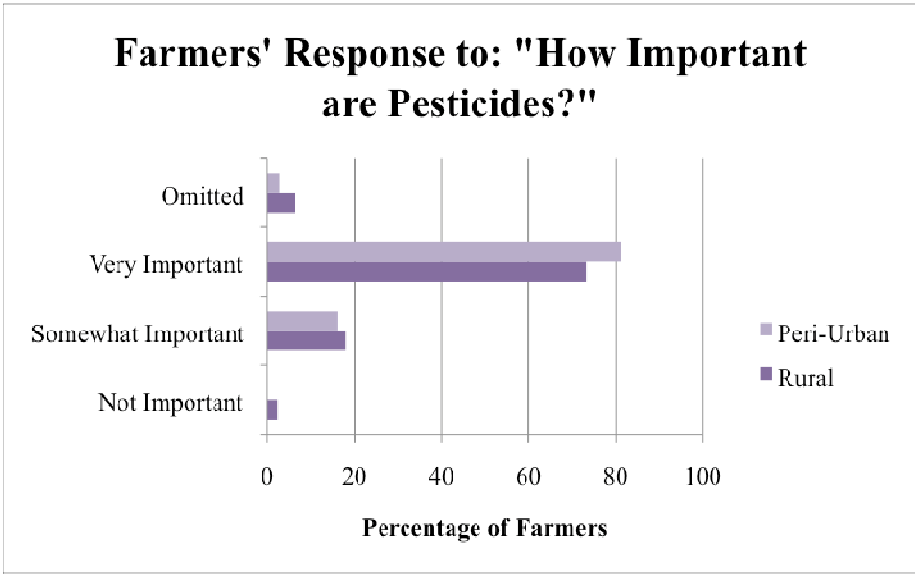


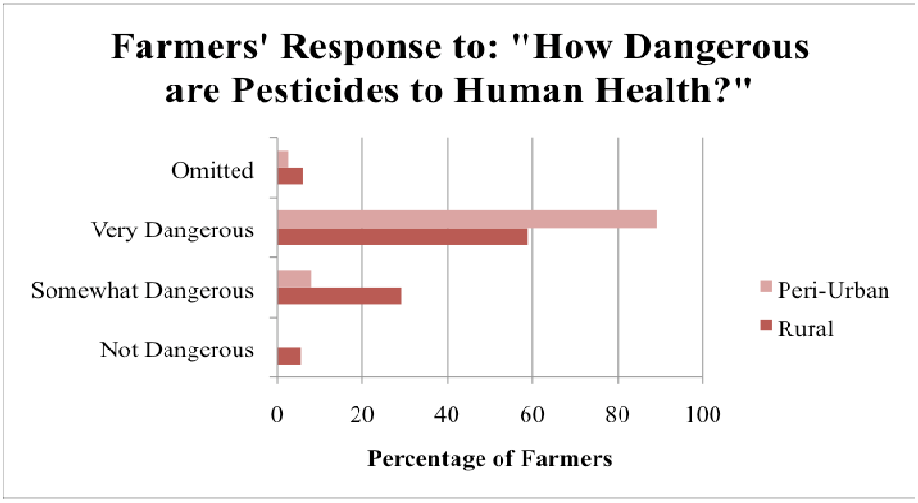


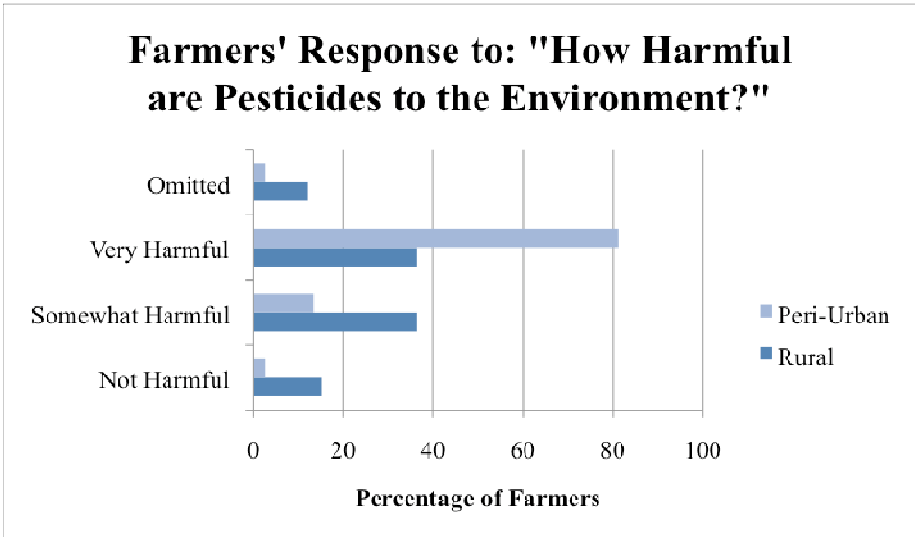

Protective Gear Worn by Farmers
Omitted
Rubber Boots
Gloves
Protective Eyewear
Breathing Protection
Face Protection
Long Sleeve Shirt & Pants
None
0
10
20
30
40
50
60
Percentage of Farmers
Peri-Urban
Rural

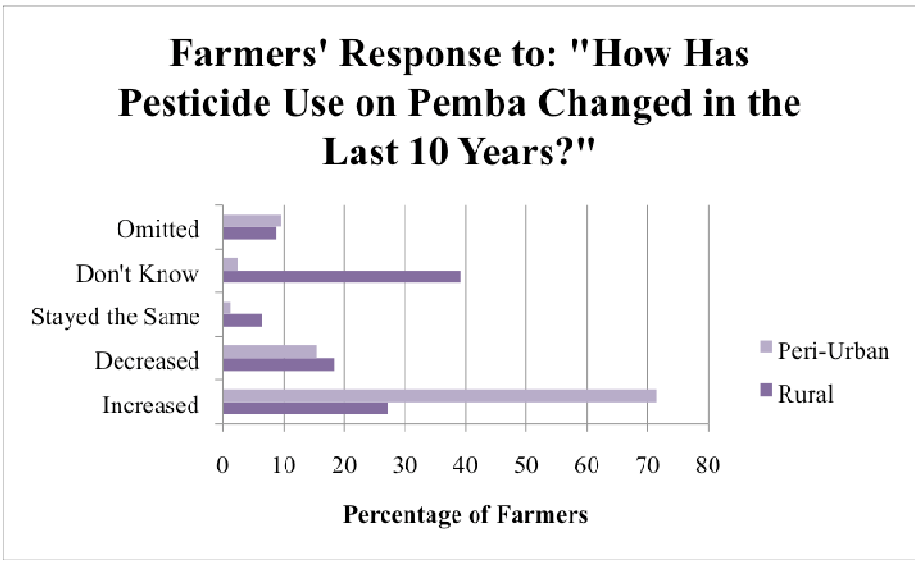

Farmers' Reasons for Not Wearing Protective Gear
Omitted
Don't Like It
Too Expensive
Not Available
0
10
20
30
40
50
60
70
Peri-Urban
Rural

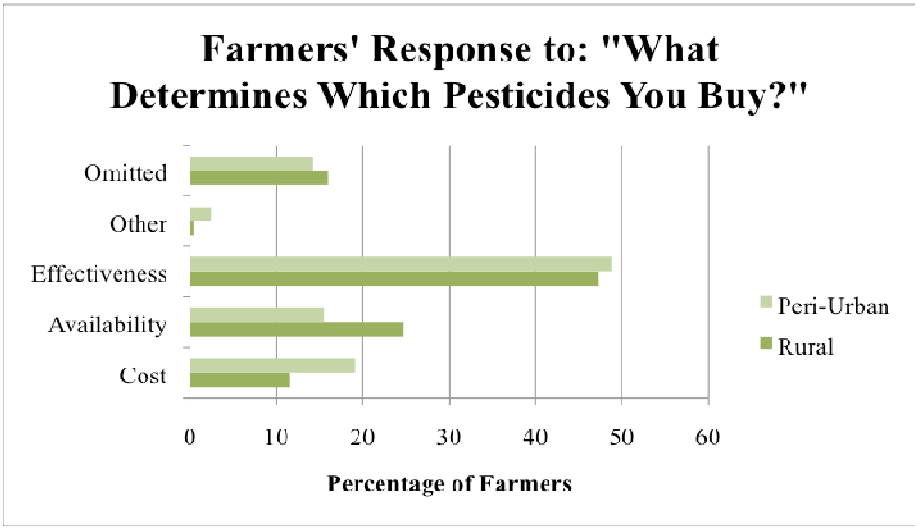

Symptoms Felt by Farmers After Pesticide Use
Omitted
Other
Itching
Burning
Vomiting
Dizziness
None
0
10
20
30
40
50
Percentage of Farmers
Peri-Urban
Rural


Farmers' Response to: "How Important are Pesticides?"
Omitted
Very Important
Somewhat Important
Not Important
0
20
40
60
80
100
Percentage of Farmers
Peri-Urban
Rural


Farmers' Response to: "How Dangerous are Pesticides to Human Health?"
Omitted
Very Dangerous
Somewhat Dangerous
Not Dangerous
0
20
40
60
80
100
Percentage of Farmers
Peri-Urban
Rural


Farmers' Response to: "How Harmful are Pesticides to the Environment?"
Omitted
Very Harmful
Somewhat Harmful
Not Harmful
0
20
40
60
80
100
Percentage of Farmers
Peri-Urban
Rural


Farmers' Response to: "How Has Pesticide Use on Pemba Changed in the Last 10 Years?"
Omitted
Don't Know
Stayed the Same
Decreased
Increased
0
10
20
30
40
50
60
70
80
Percentage of Farmers
Peri-Urban
Rural


Farmers' Response to: "What Determines Which Pesticides You Buy?"
Omitted
Other
Effectiveness
Availability
Cost
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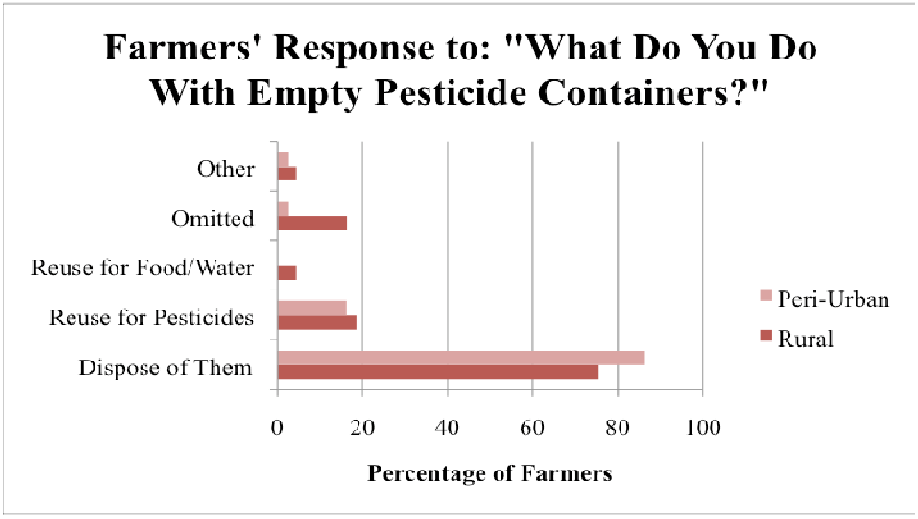
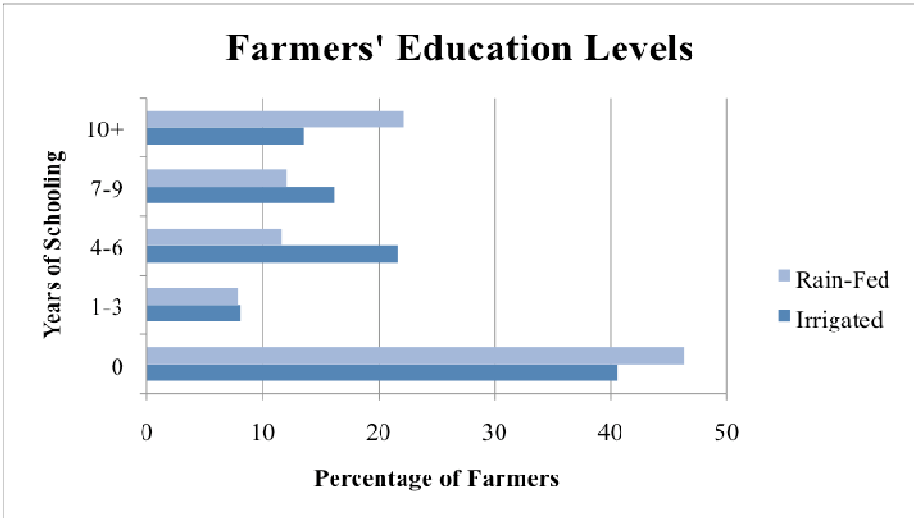
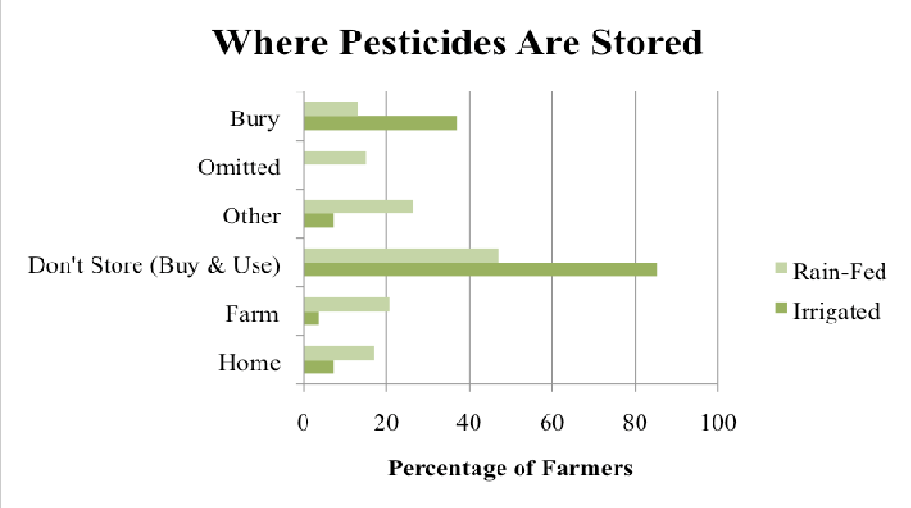
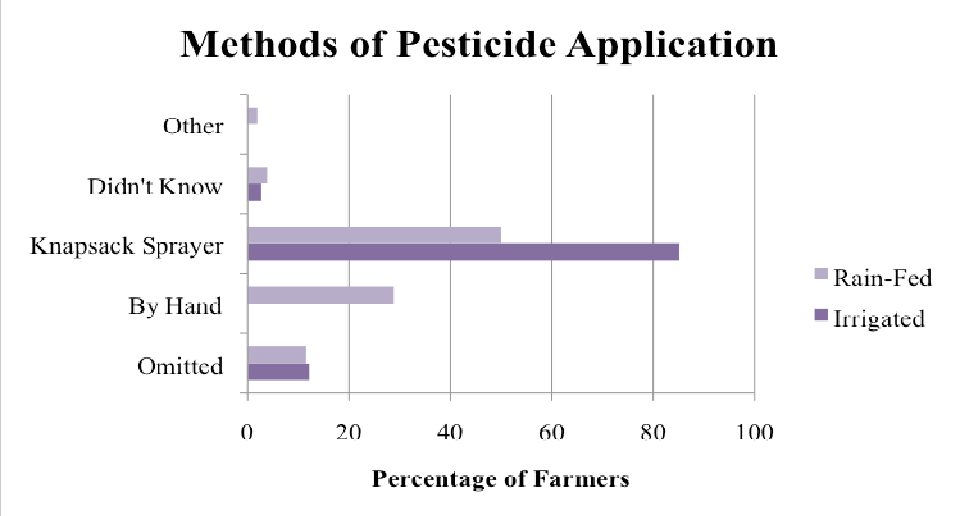
10
20
30
40
50
60
Percentage of Farmers
Peri-Urban
Rural

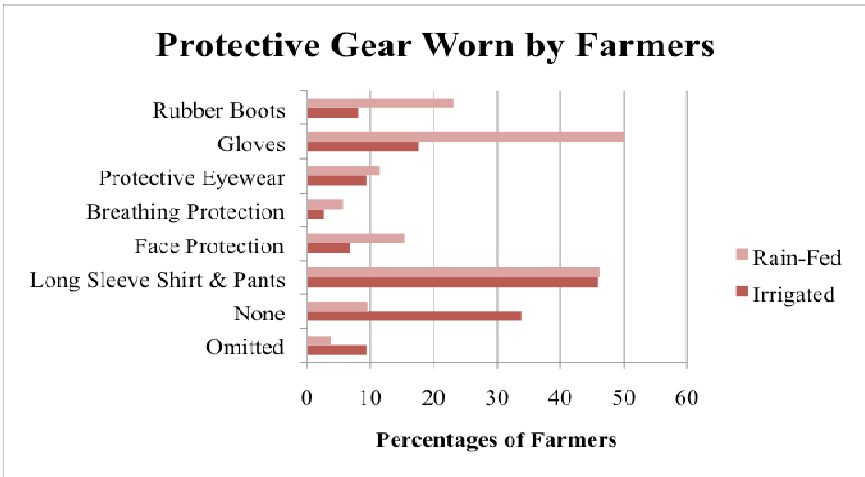

Farmers' Response to: "What Do You Do With Empty Pesticide Containers?"
Other
Omitted
Reuse for Food/Water
Reuse for Pesticides
Dispose of Them
0
20
40
60
80
100
Percentage of Farmers
Peri-Urban
Rural

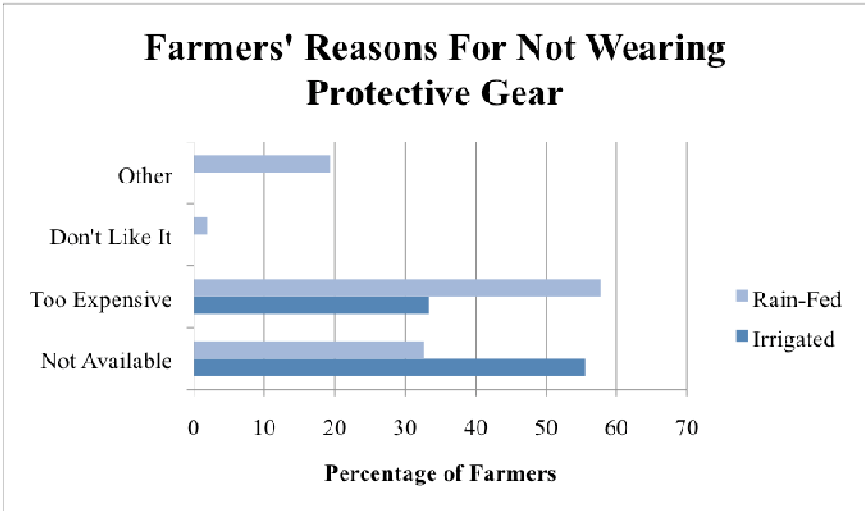
Graphs – Irrigated vs. Rain-Fed

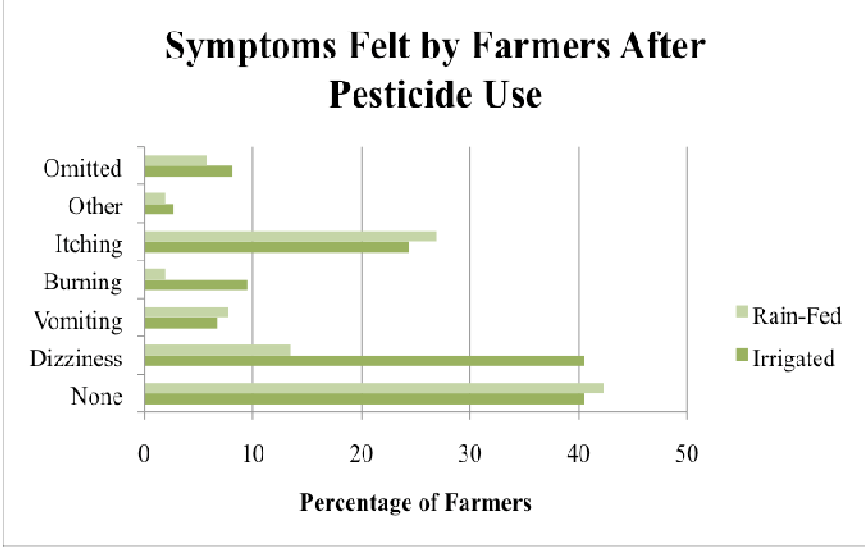


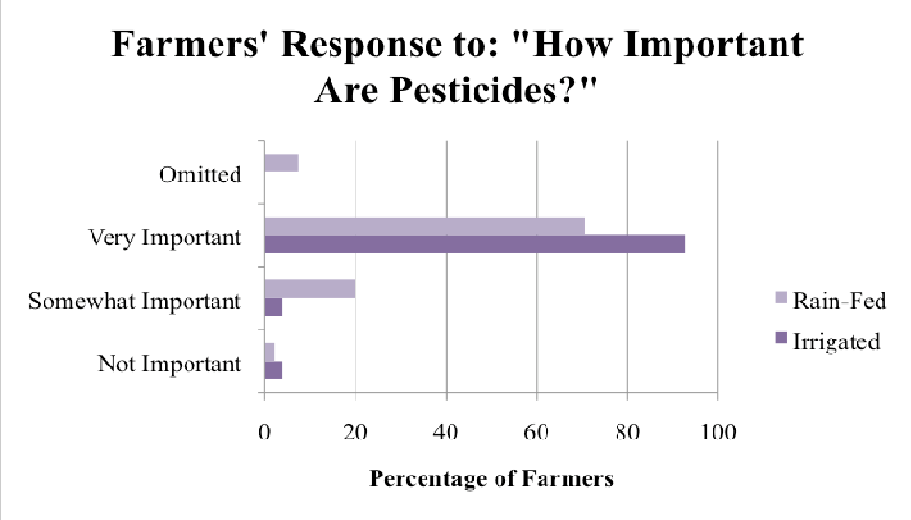


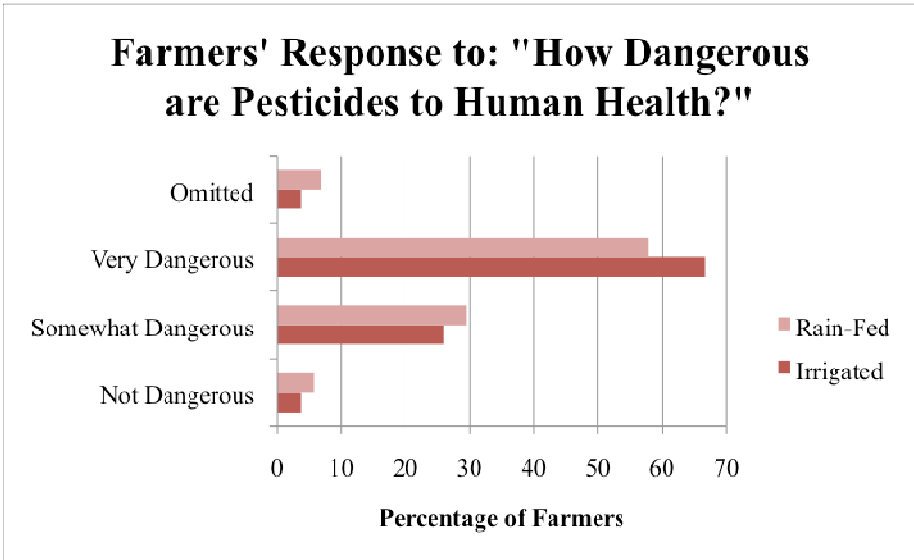


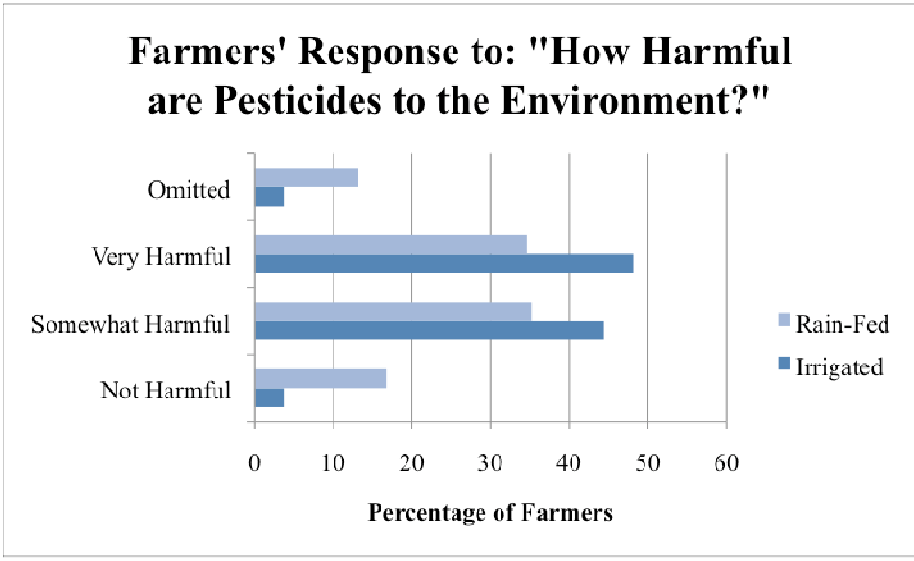

Protective Gear Worn by Farmers
Rubber Boots
Gloves
Protective Eyewear
Breathing Protection
Face Protection
Long Sleeve Shirt & Pants
None
Omitted
0
10
20
30
40
50
60
Percentages of Farmers
Rain-Fed
Irrigated

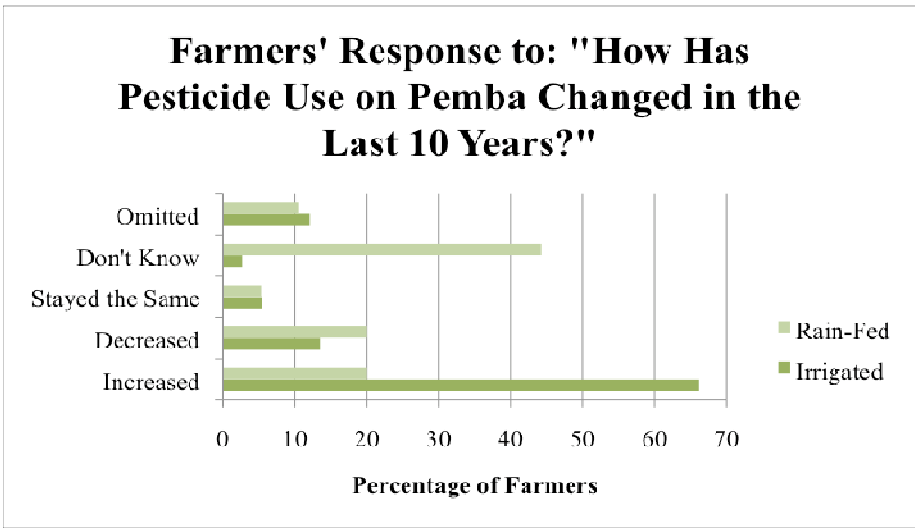

Farmers' Reasons For Not Wearing Protective Gear
Other
Don't Like It
Too Expensive
Not Available
0
10
20
30
40
50
60
70
Percentage of Farmers
Rain-Fed
Irrigated

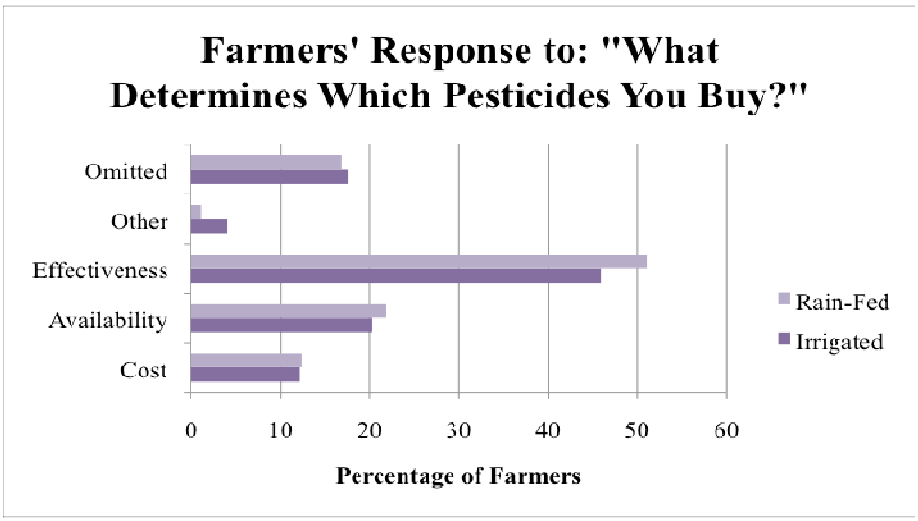

Symptoms Felt by Farmers After Pesticide Use
Omitted
Other
Itching
Burning
Vomiting
Dizziness
None
0
10
20
30
40
50
Percentage of Farmers
Rain-Fed
Irrigated

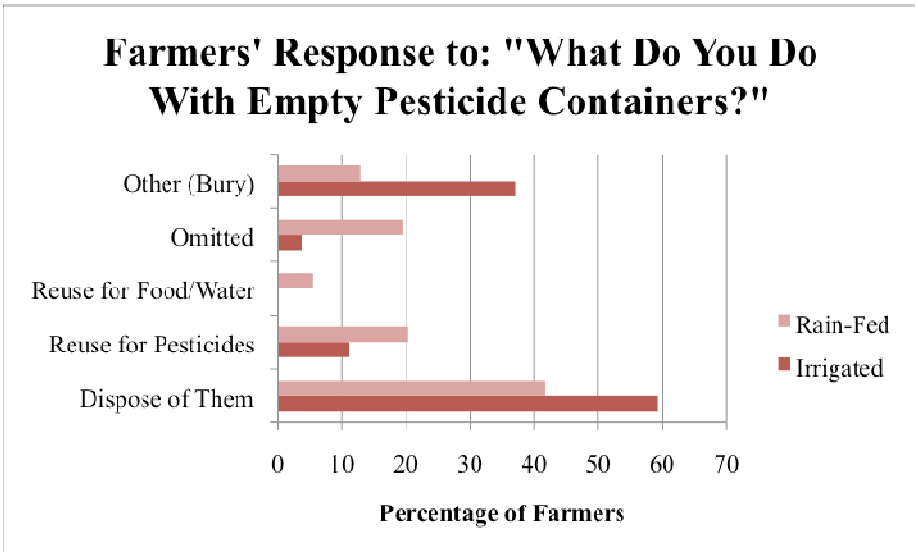

Farmers' Response to: "How Important Are Pesticides?"
Omitted
Very Important
Somewhat Important
Not Important
0
20
40
60
80
100
Percentage of Farmers
Rain-Fed
Irrigated


Farmers' Response to: "How Dangerous are Pesticides to Human Health?"
Omitted
Very Dangerous
Somewhat Dangerous
Not Dangerous
0
10
20
30
40
50
60
70
Percentage of Farmers
Rain-Fed
Irrigated


Farmers' Response to: "How Harmful are Pesticides to the Environment?"
Omitted
Very Harmful
Somewhat Harmful
Not Harmful
0
10
20
30
40
50
60
Percentage of Farmers
Rain-Fed
Irrigated


Farmers' Response to: "How Has Pesticide Use on Pemba Changed in the Last 10 Years?"
Omitted
Don't Know
Stayed the Same
Decreased
Increased
0
10
20
30
40
50
60
70
Percentage of Farmers
Rain-Fed
Irrigated


Farmers' Response to: "What Determines Which Pesticides You Buy?"
Omitted
Other
Effectiveness
Availability
Cost
0
10
20
30
40
50
60
Percentage of Farmers
Rain-Fed
Irrigated


Farmers' Response to: "What Do You Do With Empty Pesticide Containers?"
Other (Bury)
Omitted
Reuse for Food/Water
Reuse for Pesticides
Dispose of Them
0
10
20
30
40
50
60
70
Percentage of Farmers
Rain-Fed
Irrigated